NOTICE

All drawings located at the end of the document

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Interim Measures/ Interim Remedial Action Decision Document

903 Pad and Windblown Soils (Operable Unit 2)

Environmental Restoration
Rocky Flats Environmental Technology Site

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November 1995

RF/ER 95 0116 UN

Interim Measures/Interim Remedial Action Decision Document

Rocky Flats Environmental Technology Site
903 Pad and Windblown Soils
(Operable Unit No 2)

Rocky Mountain Remediation Services
P O Box 464
Golden, Colorado
80402 0464

Prepared For

United States Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado

November 1995

ACRONYMS ABBREVIATIONS AND INITIALISMS

AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
Am	americium
AOC	area of concern
ARAR	applicable or relevant and appropriate requirements
ATTIC	Alternative Treatment Technology Information Center
bgs	below ground surface
BRA	baseline risk assessment
BSL	background screening level
CAMU	corrective action management unit
C/RAO	corrective/remedial action objective
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
Ci	curie
cm	centimeter
CMS/FS	corrective measures study/feasibility study
COC	chemical of concern
cpm	counts per minute
Cr	chromium
CR	cancer risk
CT	central tendency
DAA	detailed analysis of alternatives
DCG	derived concentration guideline
DOE	U S Department of Energy
DOT	(U S or Colorado) Department of Transportation
dpm	disintegrations per minute
EP	extraction procedure
EPA	U S Environmental Protection Agency
ERA	ecological risk assessment
ET	evapotranspiration
FR	Federal Register
FS	feasibility study
FY	fiscal year
g	gram
GRA	general response actions
HASL	Health and Safety Laboratory
HEPA	high-efficiency particulate air
Hg	mercury
HHRA	human health risk assessment
HI	hazard index
HQ	noncancer hazard quotient
IA	industrial area
IAG	Interagency Agreement
IHSS	individual hazardous substance sites
IM/IRA	interim measures/interim remedial action
IROD	interim record of decision
kg	kilogram

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TABLE OF CONTENTS

L	liter
mg	milligram
μCurie	microcurie
μg	micrograms
μmhos	micromhos
mm	millimeter
mrem	millirem
NAPL	nonaqueous phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	operable unit
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PCB	polychlorinated biphenyl
PCOC	potential chemical of concern
PM_{10}	particulate mater less than 10 microns in diameter
ppm	parts per million
Pu	plutonium
RBC	risk based concentration
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA facility investigation/remedial investigation
RFLII	Rocky Flats Local Impact Initiative
RFP	Rocky Flats Plant
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
ROM	roughness of magnitude
RREL	Risk Reduction Environmental Laboratory
SF	cancer slope factor
SSRIP	Subsurface Soil Remediation Implementation Plan
SVOC	semivolatile organic compound
TBC	to be considered
TBD	to be determined
TSCA	Toxic Substances Control Act
TSD	treatment storage and disposal
U	uranium
UCL_{95}	95 percent upper confidence limit
UHSU	upper hydrostratigraphic unit

EXECUTIVE SUMMARY

This Interim Measures/Interim Remedial Action (IM/IRA) Decision Document provides an expedited remedial action strategy for the 903 Pad and Windblown Soils located in Operable Unit 2 (OU 2) at the Rocky Flats Environmental T chnology Site (RFETS) formerly the Rocky Flats Plant (RFP) in Jefferson County Colorado The U S Department of Energy (DOE) is requesting comment and approval from the public the U S Environmental Protection Agency (EPA) Region VIII and the Colorado Department of Public Health and the Environment (CDPHE) formerly the Colorado Department of Health (CDH) Under the terms of the Interagency Agreement (IAG) dated January 22 1991 both the EPA and CDPHE were designated as joint lead regulatory agencies for OU 2

The Individual Hazardous Substance Sites (IHSSs) of primary concern are the 903 Pad Drum Storage Site (IHSS 112) and the 903 Pad Lip Area (IHSS 155) The DOE also intends to address all surficial soils in OU 2 in this IM/IRA including IHSS 183 the Gas Detoxification Site IHSS 216 3 East Spray Field South and IHSS 216 2 East Spray Field Center The implementation of this IM/IRA will be consistent with the final remedy for OU 2

Based on the previous Resource Conservation and Recovery Act (RCRA) facility investigation/remedial investigation (RFI/RI) various IM/IRA alternatives have been identified and evaluated to

Remediate the OU 2 sources of contamination to protect human health and the environment from unacceptable exposure to contaminants via inhalation and ingestion pathways and to minimize the magnitude of migration pathways to surface water

Provide surface soil remediation that will be consistent with the final corrective action decision (CAD) and record of decision (ROD) for OU 2

Remediation alternatives that were potentially applicable to OU 2 are identified and evaluated in this IM/IRA Decision Document These alternatives present a wide range of actions and include

No further action

Institutional controls

Capping contaminated materials with an enhanced vegetative cover

Excavation of all contaminated materials for onsite disposal

Excavation of all contaminated materials for ex situ treatment and return to excavated surface soil area

Based on the results of the detailed analysis of the IM/IRA alternatives the DOE recommends that contaminated surface soils beneath the 903 Pad Drum Storage Site and within a 3 1 acre area adjacent to the 903 Pad be excavated and dispositioned in the onsite sitewide waste management facility These areas have concentrations of radionuclides above remediation goals Remediation goals are soil concentrations that would result in a 15 millirem annual radiation dose for the most applicable exposure scenario (see below) Radionuclides are the only constituents exceeding remediation goals

Remediation Goals

Radionuclide/Exposure Scenario	Office-Worker Exposure Scenario (pCi/gram)	Open-Space Exposure Scenario (pCi/gram)
Americium 241	142	1430
Plutonium 239	1640	16100

The excavation and disposal alternative will eliminate potential exposure to contaminated surface soils via direct contact ingestion and inhalation due to the removal of the majority of the contamination source The proposed alternative will be consistent with the final remedy for the OU 2 surface soils and is the most cost effective alternative based on a present worth analysis The excavation and disposal alternative is also consistent with the DOE goal of centrally locating contaminated media in a controlled and monitored onsite sitewide waste management facility

PART I
DECLARATION

I 1 PROBLEM DEFINITION OBJECTIVES AND PURPOSE

This interim measures/interim remedial action (IM/IRA) decision document was prepared to provide an expedited remedial action strategy for the 903 Pad and Windblown Soils located in Operable Unit No 2 (OU 2) at the Rocky Flats Environmental Technology Site (RFETS) formerly the Rocky Flats Plant (RFP) in Jefferson County Colorado These recommendations are presented as an IM/IRA This decision document is submitted by the U S Department of Energy (DOE) to request comment and approval from the public the U S Environmental Protection Agency (EPA) Region VIII and the Colorado Department of Public Health and Environment (CDPHE) formerly the Colorado Department of Health (CDH) Under the terms of the Interagency Agreement (IAG) dated January 22 1991 both the EPA and CDPHE were designated as joint lead regulatory agencies for OU 2

The DOE initiated a corrective measures study/feasibility study (CMS/FS) for OU 2 in accordance with the IAG This effort included the development of corrective/remedial action objectives (C/RAOs) the screening of process options and remedial technologies and the development of remedial alternatives During development of the CMS/FS the OU 2 subsurface source areas were determined to be candidates for accelerated actions and have since been managed as separate actions Remediation of OU 2 groundwater contamination has been proposed to be conducted under a sitewide cleanup action as part of the sitewide assessment/accelerated action program

In the spring of 1995 an unusually heavy rainfall occurred which contributed to the DOE now proposing that the 903 Pad and Windblown Soils (OU 1 and OU 2 surface soils) be remediated through an expedited IM/IRA program A 20 year rainfall event on May 17 1995 coupled with the surface soils being saturated with water resulted in sheet flow of surface water across the ground surface Total precipitation in May was 270% of the monthly average This overland flow resulted in soil erosion in areas surrounding the 903 Pad and washed out a culvert in the 903 Pad Lip Area The surface water runoff contacted soils contaminated with plutonium 239/240 (Pu 239/240) and americium 241 (Am 241) and may have transported them down the hillside This was considered a significant event because sampling data collected can be evaluated with respect to surface water runoff

The DOE proposes this IM/IRA to remediate contaminated surface soils that pose a risk to human health and the environment The IAG requires that an appropriate range of C/RAOs be established to screen and evaluate potential remedial alternatives At a minimum the C/RAOs are to be developed for the protection of human health and the environment These objectives should specify the contaminants and media of interest exposure pathways and acceptable contamination levels or ranges of levels for each exposure route

Technical Memorandum No 2 (DOE 1995c) for the OU 2 CMS/FS identified the following C/RAOs for surface soil These C/RAOs shall be applied to the 903 Pad and Windblown Soils IM/IRA

Remediate contaminated surface soil to nonzero chemical specific applicable or relevant and appropriate requirements (ARARs) or to be considered (TBCs) criteria as appropriate

In the absence of ARARs or TBCs remediate contaminated surface soils so that they are within an acceptable risk range (excess cancer risk greater than 10^{-4} to 10^{-6} or a hazard index of greater than one for noncarcinogens) considering the reasonable maximum exposure scenario

The general programmatic objectives of this IM/IRA are to

Eliminate or minimize unacceptable airborne dispersion of contamination

Eliminate or minimize surface water runoff dispersion of contamination

Eliminate biological transport of contamination

Develop a corrective measure to repair any erosional damage that may have been caused by the Spring 1995 precipitation event and to prevent future erosional damage as appropriate

Be consistent with the final remedy for OU 2 by meeting remediation goals

Comply with ARARs and TBCs and/or risk based remediation standards for surface soils

Eliminate or minimize the potential spread of contaminants during construction

Minimize the generation of new waste requiring treatment storage and/or disposal

Propose a remedial alternative that would be acceptable to the community and approved by the regulatory agencies

Implement the accepted remedial alternative within congressionally approved fiscal constraints

The primary individual hazardous substance sites (IHSSs) of concern in this IM/IRA are the 903 Pad Drum Storage Site (IHSS 112) and the 903 Pad Lip Area (IHSS 155) The DOE also intends to address all surficial soils previously in OU 2 in this IM/IRA including (1) IHSS 183 the Gas Detoxification Site (2) IHSS 216 3 East Spray Field South and (3) IHSS 216 2 East Spray Field Center

Implementation of this IM/IRA will be consistent with the final remedy for OU 2 The current plan for the remediation of all of the IHSSs previously within OU 2 is displayed in Table I 1 IHSSs exhibiting high risk will be remediated in an accelerated fashion Low risk IHSSs will be assessed in a sitewide program Those IHSSs listed under the sitewide assessment/accelerated action program will be addressed under separate cover

Part I of this IM/IRA decision document defines the issues associated with the 903 Pad and Windblown Soils and summarizes the results of the Resource Conservation and Recovery Act (RCRA) facility investigation/remedial investigation (RFI/RI) and human health risk assessment (HHRA) Part II of this document presents the remedial alternatives that were considered the action specific ARARs and TBC implementation strategy and design criteria for the proposed alternative

This proposed IM/IRA will be submitted to the EPA Region VIII and the CDPHE for review and comment The DOE will open a public comment period for a minimum of 60 days In addition the DOE will hold a public hearing if requested by the public EPA or CDPHE

At the conclusion of the public comment period DOE will prepare a responsiveness summary for EPA and CDPHE review and approval The responsiveness summary will be provided as Part III of the final IM/IRA decision document The IM/IRA decision document will become the Record of Decision (ROD) for RFETS

Implementation of the remedial action will commence upon EPA and CDPHE approval of the responsiveness summary and the final IM/IRA decision document (contingent on funding availability) As required by the IAG DOE will make the EPA and CDPHE approved IM/IRA decision document available to all interested parties at least 10 days prior to the commencement of any remedial actions Remedial action is anticipated to begin in fiscal year (FY) 1997

Table I 1
Current Plan for Remediation of OU 2 IHSSs

IHSS	Interim Measures/Interim Response Action	Sitewide Assessment/Accelerated Action Program
903 Pad Drum Storage Site (112)	X	
903 Pad Lip Area (155)	X	
East Spray Fields (216 2)	X	
East Spray Field (216 3)	X	
Gas Detoxification Site (183)	X	
Mound Site (113)		X
Oil Burn Pit 2 Site (153)		X
Pallet Burn Site (154)		X
Reactive Metal Destruction Site (140)		X
Trench T 1 (108)		X
Trench T 2 (109)		X
Trench T 3 (110)		X
Trench T 4 (111 1)		X
Trench T 5 (111 2)		X
Trench T 6 (111 3)		X
Trench T 7 (111 4)		X
Trench T 8 (111 5)		X
Trench T 9 (111 6)		X
Trench T 10 (111 7)		X
Trench T 11 (111 8)		X
Trench T 12		X
Trench T 13		X
UHSU Groundwater		X

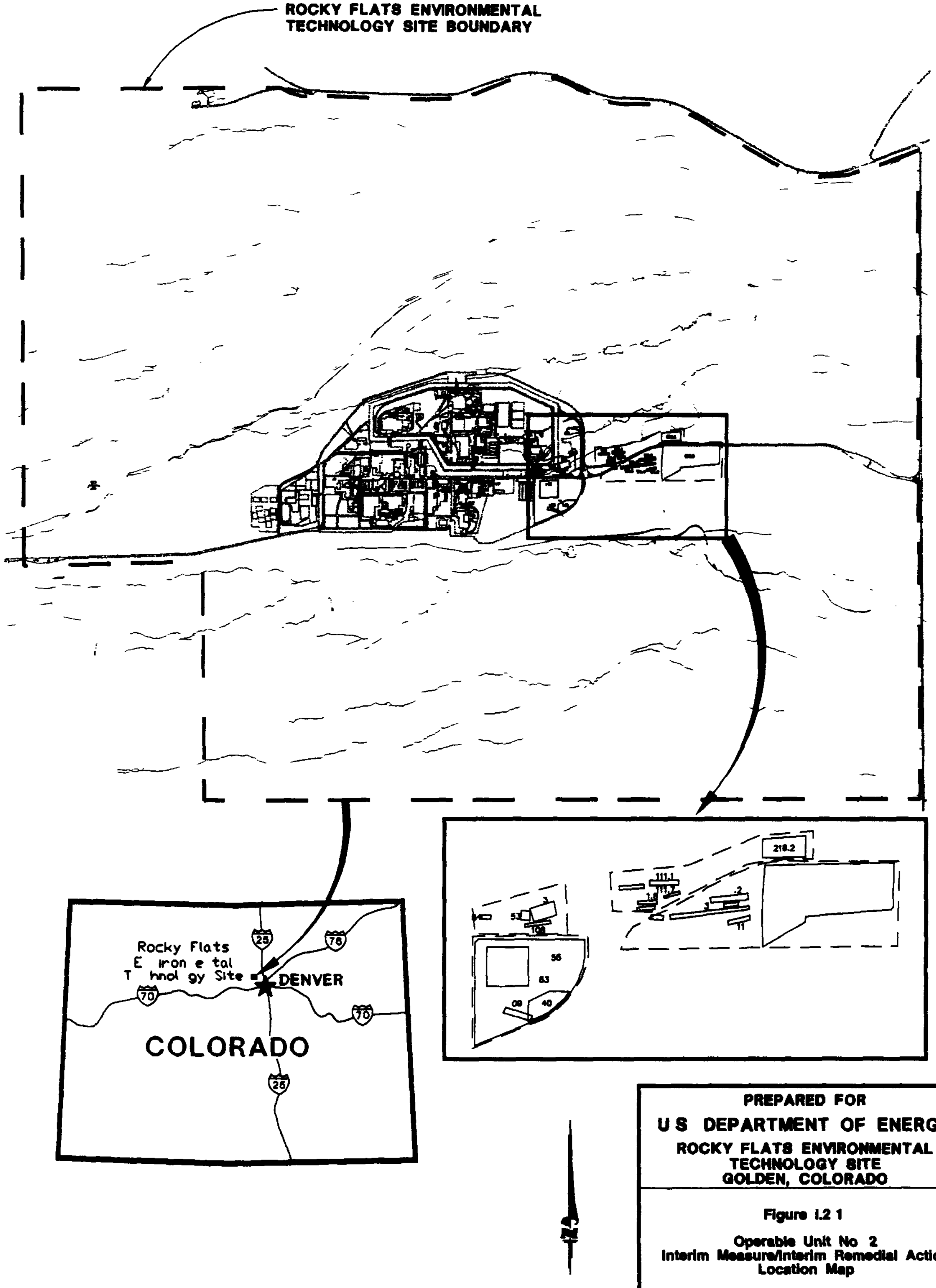
[a] Included in this IM/IRA decision document

I 2 SITE OVERVIEW

RFETS is a government owned contractor operated facility formerly used for the fabrication of special nuclear materials for national defense The 6 550 acre site is located in northern Jefferson County Colorado approximately 16 miles northwest of Denver The cities of Boulder Broomfield Westminster Golden and Arvada are located less than 10 miles to the northwest northeast east south and southeast respectively Figure I 2 1 presents the location of OU 2 at the RFETS and in relation to the State of Colorado

Centrally situated within the RFETS boundary is a 400 acre security area that contains the buildings and other structures formerly used to support the weapon component fabrication operations The remaining 6 150 acres consist of undeveloped land used as a buffer zone to restrict access to the operations area Fabrication operations began at the RFETS in 1951 and ceased in 1991 when the RFETS mission was changed to environmental restoration and waste management The fabrication operations resulted in the generation of liquid and solid wastes containing radioactive and hazardous constituents managed in various waste processing units

OU 2 includes administratively controlled areas east and southeast of the security area Contained in OU 2 are multiple IHSSs including a former drum storage area material burn surface areas spray fields and disposal trenches Figure I 2 2 shows a map of the IHSSs previously within OU 2 This IM/IRA addresses the surface soils within this area and the associated IHSSs described earlier



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U S DEPARTMENT OF ENERGY

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Figure I.2 1

Operable Unit No 2 Interim Measure/Interim Remedial Action Location Map

1 3 SURFACE SOIL INCLUDING NATURE AND EXTENT OF CONTAMINATION

The following sections describe the nature and extent of the contamination associated with the 903 Pad and Windblown Soils This information is presented by IHSS where applicable

1 3 1 903 PAD DRUM STORAGE SITE (IHSS 112)

The 903 Pad Drum Storage Site also referred to as the 903 Pad is located southeast of the RFETS Industrial Area (IA) Drums that contained radioactively contaminated oils and solvents were stored at this site from the summer of 1958 to January 1967 Drum storage at the 903 Pad occurred over most of the current pad area which was an open field Maximum storage of drums in the area was in April 1965 based on historical photographs A description by Catkins (1970) of the drums that were stored at the drum storage site follows

> Most of the drums transferred to the field were nominal 55 gallon drums but a significant number were 30 gallon drums that were not completely full Approximately three fourths of the drums were plutonium contaminated while most of the balance contained uranium isotopes Of those containing plutonium most were lathe coolant consisting of a straight chain hydrocarbon mineral oil (Shell Vitrea) and carbon tetrachloride in varying proportions Other liquids were contained including hydraulic oils vacuum pump oil trichloroethylene perchloroethylene silicone oils and acetone still bottoms Originally contents of the drums were indicated on the outside but these markings became illegible through weathering and no other records were kept of the contents Oil leakage was recognized and in 1959 (or possibly earlier) ethanolamine was added to the oil to reduce the corrosion rate of the steel drums

Drum leakage was noted at the 903 Pad Drum Storage Site as early as 1959 Initial corrective action consisted of transferring the contents of leaking drums to new drums and installing a fence around the area to restrict access approximately 420 drums showed evidence of leakage and of these an estimated 50 leaked their entire contents (Dow Chemical 1971) An estimated 5 000 gallons of liquid (Freiberg 1970) containing 86 grams (g) of plutonium (5 3 Curies [Ci]) leaked into the soil (Dow Chemical 1971)

A heavy rainstorm in August 1967 caused contaminants to migrate into a ditch south and southeast of the drum storage site (Dow Chemical 1971) During an investigation conducted by the Atomic Energy Commission (AEC) Health and Safety Laboratory (HASL) it was estimated that as much as 125 g (total) of

Pu 239 (7 7 Ci) were released from the 903 Pad Drum Storage Site and redistributed by winds (Krey and Hardy 1970)

During radiological monitoring of the 903 Pad in 1971 four hot spots were identified This led to the removal of 31 kilograms (kg) of depleted uranium and up to 10 3 milligrams (mg) of plutonium from beneath the asphalt cover During sampling activities associated with this removal action an oil layer contaminated with depleted uranium was discovered in two separate boreholes at depths of 45 7 and 76 2 centimeters (cm) (18 inches and 30 inches) A clay layer was noted beneath the contaminated zone At that time no contamination was found below the clay layer and it was believed that the clay layer served as a natural barrier to downward migration of contaminants However the draft OU 2 RFI/RI identified radiological contamination at decreasing concentrations from 0 6 to 6 meters (2 to 20 feet) below ground surface (bgs) The presence of organics in this layer is unknown but organics are not currently believed to be present

1 3 2 903 PAD LIP AREA (IHSS 155)

During drum storage removal and cleanup activities associated with the 903 Pad Drum Storage Site wind and rain redistributed plutonium beyond the 903 Pad Contamination was primarily to the south and east extending to the southeast perimeter road An estimated 16 g of Pu 239/240 were redistributed beyond the asphalt pad in an area exceeding 2 000 acres The most contaminated area called the 903 Pad Lip Area was located immediately adjacent to the 903 Pad to the south and southeast as shown in Figure 1 2 2

Contaminated soil identified in the past through radiological monitoring has been excavated from the 903 Pad Lip Area In 1973 an aerial radiological survey detected radioactive concentrations in the 903 Pad Lip Area that were greater than 2 000 counts per minute (cpm) In 1975 eight 55 gallon drums of soil were removed from the 903 Pad Lip Area as a pilot scale test for sampling techniques The details of this test are unknown Ambient air monitoring during excavation did not detect plutonium in concentrations that would endanger onsite workers the public or the environment

In 1976 approximately 113 3 cubic meters (4 000 cubic feet) of soil were removed from within the 903 Pad Lip Area Soil removal activities were conducted again in 1978 when an estimated 4 000 square meters (43 000 square feet) of soil that exceeded 2 000 cpm were removed to a depth of approximately 3 5 cm (1 4 in) All waste was packaged and shipped to the Nevada Test Site (DOE 1992) The excavated area was backfilled and revegetated

Soil cleanup was performed along the eastern edge of the 903 Pad Lip Area in 1984 (Setlock 1984) A total of 214 tri wall pallets of contaminated soil were removed from the area The soil disposal location was not provided by Setlock (1984) The excavated area was covered with clean topsoil and vegetated

Although several removal actions have been conducted in the 903 Pad Lip Area recent sampling has detected the presence of elevated concentrations of Pu 239/240 and Am 241 The vertical profile of actinides in the region follows a unique profile with depth In general the highest activity is found in the top 3 cm (1 2 inches) followed by a significant decrease between 6 and 9 cm (2 4 and 3 4 inches) An increase in actinide activity is found at the original surface level beneath the revegetated fill level The increase of actinide activity in the top 3 cm (1 2 inches) of fill material cannot be explained by the previous historical wind dispersion transport from the 903 Pad Drum Storage Site

Based on the site history and other information burrowing animals ant colonies and earthworms have been observed at the 903 Pad Lip Area and are potential transport mechanisms for residual contamination that remains in the 903 Pad Lip Area Geological features of the site such as lateral discontinuities and macroporosity could also contribute to the redistribution of contaminants (Litaor et al 1994) This redistribution is apparent in the distribution of Pu 239/240 in the sand layer over the 903 Pad Lip Area discussed above

1 3 3 Remaining OU 2 Surface Soils

The remaining surface soil contamination is in

IHSSs 183 216 2 216 3

Areas primarily to the east and southeast of the 903 Pad Lip Area (buffer zone east of the 903 Pad and Lip Area)

Operable Unit 1 (OU 1) surface soils contiguous to OU 2 which are contaminated with low levels of plutonium OU 1 surface soil in this area is believed to have been contaminated by wind transport from the 903 Pad Drum Storage Site

The Gas Detoxification Site IHSS 183 includes Building 952 which was constructed as a Toxic Gas Storage Building This building is located within the IHSS 155 boundary and the contents of the building previously have been determined to have been contaminated by Pu 239/240 and Am 241 from IHSSs 112 and 155 (DOE 1992) There are no historical reports of surface soil contamination due to operations in this building and the RFI/RI did not identify any other contaminants within this area Therefore IHSS 183 will be remediated based on the presence of Pu 239/240 and Am 241

The East Spray Fields IHSSs 261 2 and 261 3 were used to reduce water levels in Pond B 3 which receives sanitary wastewater from the IA Pond B 3 water was sprayed over the IHSSs resulting in saturation and in some instances overland flow A chromic acid spill in Building 444 resulted in the inadvertent discharge of an estimated 4 7 pounds of chromium to Pond B 3 which was subsequently sprayed on the East Spray Fields Following the chromium release 34 samples were collected from spray field surface soils Chromium concentrations in surface soil are below remediation goals so remediation is not necessary for chromium

Contamination in the remaining surface soil area is attributed primarily to wind dispersion from the 903 Pad Drum Storage Site Plutonium contamination also potentially originated from historical fires and stack effluent of the production facilities The RFI/RI data indicate a large variability in Pu 239/240 and Am 241 activity near the 903 Pad source area between the samples taken using CDPHE sampling protocol and the RFETS sampling protocol (DOE 1995b) This variability probably occurred due to wind erosion some solubility and leachability and the hot particle phenomenon As defined by Winsor and Whicker (1979) a hot particle has an activity above 450 picoCuries per gram (pCi/g) and it is usually an agglomeration of numerous host soil grains and plutonium oxides Studies conducted at the RFETS indicated a significant variation in the sizes and spatial distributions of the plutonium particles in the soil Therefore a large variability in a short sampling interval is not surprising Additionally the RFETS soil sampling techniques involve collecting large quantities (up to 5 kg) of which only a representative sample is processed and analyzed This could explain the variation in actinide activities

Other possible causes of the large variability in actinide activity across the remediation area include prior vehicle and construction disturbance and past cleanup practices A 1994 aerial photograph taken by the Radiological Assessment Group showed that large vehicular and/or construction disturbances occurred in at least one sampling plot Based on the required sampling protocol involving 5 to 10 subsamples in the middle of the plot samples could have been taken in a highly disturbed location that was not representative of the original contaminant loading

I 4 SITE CHARACTERISTICS AND ENVIRONMENTAL SETTING

Appendix A describes the site characteristics and environmental setting of the 903 Pad and Windblown Soils Area These aspects are important in analyzing the risks to human health and the environment as well as in designing the preferred alternative Appendix A provides detailed information with respect to

- Demography and land use
- Topography and geomorphology
- Climatology meteorology and air quality
- Site and local surface water hydrology
- Site and local soils
- Regional and local geology
- Regional and local hydrogeology
- Ecology
- Social and economic resources

I 5 RFI/RI ECOLOGICAL RISK ASSESSMENT HUMAN HEALTH RISK ASSESSMENT AND REMEDIATION GOALS

This section provides a summary description of the surface soil and surface water characterization results of the ecological risk assessment (ERA) results of the human health risk assessment (HHRA) calculation of remediation goals and a screening of surface soil chemicals of concern (COCs) The 903 Pad and Windblown Soils IM/IRA will address risks associated with airborne contamination biota transport and erosion from surface water

I 5 1 SUMMARY OF RFI/RI SURFACE SOIL RESULTS

Surface soil samples were collected across an area of approximately 800 acres as shown on Figure I 5 1 The surface soil plots were 2 5 and 10 acres in size Surface soil samples were collected in 1991 via the CDPHE sampling methodology Using the CDPHE sampling method 25 equally spaced and uniformly distributed subsamples were composited within each 2 5 or 10 acre plot This method was employed to evaluate the spatial extent of contamination In 1992 the plots were resampled via the RFETS sampling method Using the RFETS sampling method ten subsamples were collected from the corners and center of two 1 meter squares spaced 1 meter apart at the center of each 2 5 and 10 acre plot The surface soil samples were collected from a depth of 5 cm using the RFETS sampling method and 6 millimeters (mm) using the CDPHE sampling method

Additional surficial soil samples were collected in 1993 through an approved field sampling plan in support of the HHRA In determining the sampling locations the OU 2 area was divided into 9 126 contiguous 50 foot by 100 foot plots Forty plots were systematically selected for sampling Six of the 40 plots were biased plot locations specifically selected for sampling because they were located within IHSSs potentially containing contaminated surface soils (based on a review of the activities conducted in OU 2) The remaining 34 plots were evenly spaced throughout the OU 2 area One composite soil sample was taken from each of the plots using a modification of the RFETS sampling method Ten subsamples were collected and composited from the corners and center of two 1 meter squares placed 1 meter apart The depth of each subsample was 5 cm

Samples collected using the CDPHE sampling method were analyzed for uranium plutonium and americium isotopes Samples collected using the RFETS sampling method were analyzed for plutonium and americium isotopes The samples collected for the HHRA were analyzed for semivolatile organic compounds (SVOCs) pesticides and polychlorinated biphenyls (PCBs) metals inorganic constituents and radionuclides

Potential chemicals of concern (PCOCs) for OU 2 are presented in Table I 5 1 PCOCs were then assessed with respect to toxicity frequency of detection and professional judgement to arrive at the surficial soil COCs of Aroclor 1254 Aroclor 1260 Bis(2 ethylhexyl)phthalate Chromium III Pu 239/240 and Am 241 Additional information regarding these results can be found in the Phase II RFI/RI Report for OU 2 (DOE 1995b)

I 5 2 SUMMARY OF THE SURFACE WATER RESULTS FROM THE STORM EVENT

Surface water samples were collected during the overland flow resulting from the May 17 1995 storm event The samples were grab samples and were analyzed for Pu 239/240 and Am 241 Figure I 5 2 presents a map of the sampling locations and analytical results No total suspended solids analyses were performed on these samples so no resuspension correlation can be made Therefore it is not currently known if plutonium is actually transported via overland flow In general though the concentrations of Pu 239/240 and Am 241 are higher in uphill locations (closest to the 903 Pad Drum Storage Site and the 903 Pad Lip Area) than in the downhill locations (closest to Woman Creek)

Table I 5 1
Analytical Results for PCOCs in Surface Soils in OU 2

Analyte	Background Screening Level(s)	Number of Samples	Number of Detections[a]	Percent Detections	Mean Concentration or Activity[b]
Semivolatile Organic Compounds (g/kg)					
Benzo(a)anthracene	NA	42	8	0 19	87
Benzo(a)pyrene	NA	42	9	21 4 '	93
Benzo(b)fluoranthene	NA	42	9	21 4 '	134
Benzo(g h i)perylene	NA	42	1	2 4 '	45
Benzo(k)fluoranthene	NA	42	2	4 8 /	73
Benzoic acid	NA	42	39	92 9 /	244
Bis(2 Ethylhexyl)phthalate	NA	42	9	21 4 '	121
Chrysene	NA	42	12	28 6 /	97
Di n Butylphthalate	NA	42	1	2 4 '	1000
Fluoranthene	NA	42	20	47 6 /	153
Indeno(1 2 3-cd)pyrene	NA	42	2	4 8 /	64
Phenanthrene	NA	42	13	31 0%	89
Pyrene	NA	42	24	57 1 '	131
Pesticides and PCBs (μg/kg)					
4 4 DDT	NA	42	1	2 4 /	26
Aroclor 1254	NA	42	2	4 8 /	580
Aroclor 1260	NA	42	2	4 8 /	450
delta BHC	NA	42	1	2 4 /	23
PCOC Metals Above Background (mg/kg)					
Calcium	9 34	74	17	23 /	33521
Chromium	19 98	74	3	4 1 /	29
Iron	21835	74	2	2 7 /	51950
Lead	49 6	74	11	14 9%	63
Silicon	2 184	74	0	0 0%	NA
PCOC Radionuclides Above Background (pCi/g)[f]					
Americium 241	0 039	69	69	100 0 /	10
Gross Alpha	28 771	35	8	22 9 /	106
Plutonium 239/240	0 094	80	80	100 0%	347
Radium 226	1 198	42	9	0 214	1
Strontium 89 90	1 213	30	12	0 4	2
Uranium 233 234	1 461	84	28	0 333	2
Uranium 235	0 107	84	18	0 214	0
Uranium 238	1 596	84	33	0 393	3

Locations SS20093 SS203993 PT006 PT010-011 PT013 PT015-016 PT019-023 PT026-038 PT044-049 PT052-057 PT061-062 PT064-068 PT072 074 PT076-081 PT084 088 PT092-096 PT100 102 PT104 109 PT112 115 PT118 123

a Radionuclide and metal results less than the background mean plus 2 standard deviations the background screening level (BSL) are considered as a background result Reported detections are above background

b The calculation for the mean concentration includes all J D and B qualified data

c Background concentrations for organic compounds were assessed on a case by-case basis

d NA Not Applicable

e For metals and radionuclides only PCOCs have been reviewed and are presented on this table

f Radionuclide activities less than or equal to zero are considered to be nondetections An estimated 5 000 gallons of liquid (Freiberg 1970) containing 86 grams (g) of plutonium (5 3 curies [Ci]) leaked into the soil (Dow Chemical 1971)

1 5 3 RESULTS OF THE ECOLOGICAL RISK ASSESSMENT

The Ecological Risk Assessment (ERA) for Walnut Creek and Woman Creek Watersheds at Rocky Flats Environmental Technological Site Volume 7 Appendix F of the Draft Final Phases I RFI/RI Report Walnut Creek Priority Drainage OU 6 and discusses the summary of ecological risk for both drainage to key receptor groups in ERA source areas including OU 2 903 Pad The receptor groups include Terrestrial Feeding Raptors and Small Mammals which cover exposure pathways for deer mice voles and Preble s meadow jumping mice and common raptors such as great horned owls These receptor groups were evaluated through the risk characterization stage however the risks were low for all species except the American kestrel

Red tailed hawks mule deer and coyotes are featured as wide ranging species and their potential exposure was assessed on a sitewide basis Since the hazard indexes for the wide ranging species were all well below 1 0 the risk to these species from PCOCs at RFETS is negligible and further evaluation is unwarranted

Risks to the American kestrel were due primarily to chromium in soils and prey Twenty one surface soil samples were collected in the vicinity of the 903 Pad Drum Storage Site and 903 Pad Lip Area Of these only 6 samples (28 percent) exceeded background concentrations It was reported that only small areas within OU 2 have chromium concentrations that could provide an intake to the American kestrel exceeding background The American kestrel has a large home range over which it forages Therefore an American kestrel would most likely only take a small fraction of prey from a localized region where chromium concentrations exceeded background The ERA concluded that it is highly unlikely that the American kestrel population is being impacted by chromium concentrations in OU 2 (RMRS August 22 1995)

1 5 4 SUMMARY OF THE HUMAN HEALTH RISK ASSESSMENT RESULTS

An HHRA was conducted as part of the Phase II RFI/RI report for OU 2 The purpose of the HHRA was to estimate the level of health risk from potential exposures to chemicals at or released from contaminant sources within OU 2 Health risks examined in this document are for the reasonable maximum exposure (RME) case which is an upper bound risk and is calculated according to EPA guidance (EPA 1989 and 1992)

The HHRA consisted of a series of four steps involving the collection and evaluation of data as they apply to risk

Data collection and evaluation
Exposure assessment

Toxicity assessment

Risk characterization

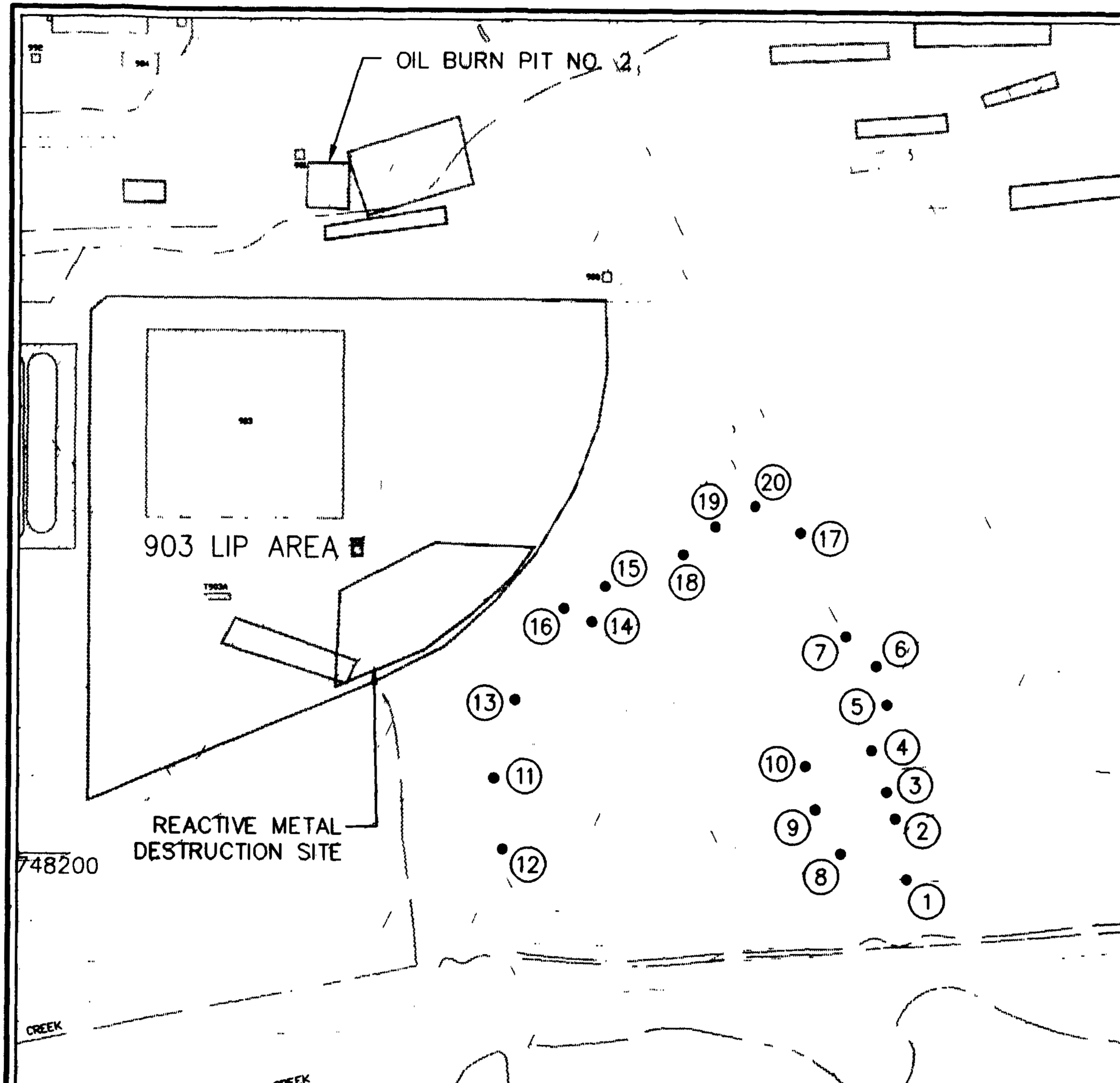
These steps are presented in detail in Appendix H of the RFI/RI report for OU 2 (DOE 1995b) For purposes of this document only the risk assessment conclusions will be discussed

1 5 4 1 Results

Table I 5 2 summarizes the results of the risk characterization step of the HHRA for area of concern (AOC) No 1 AOC No 2 and the maximum exposure areas These are the primary exposure areas assessed with the HHRA A discussion of these areas is found in Section H2 0 Data Evaluation and Aggregation of the OU 2 RFI/RI Report (DOE 1995b) The surficial soil COCs assessed in these areas were Aroclor 1254 Aroclor 1260 Bis(2 ethylhexyl)phthalate chromium III Pu 239/240 and Am 241 The table includes the total cancer risk and noncancer hazard indices (HIs) for the exposure pathways evaluated at OU 2 The HHRA supports the no further action remedial alternative for both AOC No 1 and AOC No 2 because all risk within the AOCs are within the acceptable risk range

As shown in Table I 5 2 the maximum RME cancer risk estimate was $2\ 0 \times 10^{-4}$ for a future industrial/office worker in the 30 acre maximum exposure area This risk is due to the ingestion and inhalation of Pu 239 and Am 241 in surface soils Cancer risk estimates for all other nonresidential receptors in the maximum exposure areas were within or below the EPA s target cancer risk range of $1\ 0 \times 10^{-6}$ to $1\ 0 \times 10^{-4}$ The highest cancer risk estimate of $2\ 0 \times 10^{-4}$ only slightly exceeds the EPA target risk range Noncancer HIs were below 1 for all onsite nonresidential receptors indicating no significant noncarcinogenic risk Hazard and risk estimates for offsite residents were negligible The annual radiation dose to the future industrial/office worker in the 30 acre maximum exposure area is 18 millirem The annual radiation dose estimate for all other nonresidential receptors are less than 10 millirem

The hypothetical resident was not included in the risk characterization because this exposure scenario is not applicable at the RFETS This is consistent with the recommendations of the Rocky Flats Future Site Use Work Group (RFFSUWG 1995) Therefore the residential risk calculations were not considered in making conclusions about site risk



SPRING 1995 RESULTS

SAMPLE LOCATION	Pu 239/240 (pC/L)	Am 241 (pC/L)
1	3 81	0 53
2	NA	0 63
3	NA	1 50
4	NA	0 54
5	8 44	1 36
6	NA	1 14
7	NA	1 05
8	NA	0 70
9	NA	2 11
10	12 19	2 07
11	3 84	0 64
12	2 98	0 45
13	11 16	1 53
14	247 50	48 10
15	NA	26 53
16	38 0	7 68

NA NOT APPLICABLE

LEGEND

● (1) Sampling Location and Number

0 300 600 FEET

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GOLDEN, COLORADO

Figure I.5-2

Operable Unit No 2

Interim Measure/Interim Remedial Action

Surface Water Sample Locations

ᶜ5DN1359 09/20/95 at 15 15

Table I 5 2
Summary of Estimated Health Risks

	Average Exposure (CT)		Reasonable Maximum Exposure (RME)	
	Carcinogenic Risk	Hazard Index	Carcinogenic Risk	Hazard Index
AOC No 1				
Current worker	6 0 x 10^{7}	2 0 x 10^{3}	1 0 x 10^{-}	1 0 x 10^{2}
Future industrial/office worker	2 0 x 10^{6}	6 0 x 10^{-}	8 0 x 10^{-}	4 0 x 10^{2}
Future ecological worker	1 0 x 10^{6}	5 0 x 10^{3}	4 0 x 10^{-}	2 0 x 10^{2}
Future open space use	2 0 x 10^{7}	5 0 x 10^{4}	1 0 x 10^{-}	1 0 x 10^{2}
Future construction worker	1 0 x 10^{7}	4 0 x 10^{3}	3 0 x 10^{-}	2 0 x 10^{-8}
Maximum Exposure Areas				
Future industrial/office worker (30 acres)	5 0 x 10^{-6}	1 0 x 10^{2}	2 0 x 10^{-4}	8 0 x 10^{2}
Future ecological worker (50 acres)	2 0 x 10^{6}	8 0 x 10^{3}	6 0 x 10^{-6}	4 0 x 10^{2}
AOC No 2				
Current worker	9 0 x 10^{9}	3 0 x 10^{7}	2 0 x 10^{7}	2 0 x 10^{-6}
Future industrial/office worker	4 0 x 10^{-8}	9 0 x 10^{7}	1 0 x 10^{-6}	1 0 x 10^{-}
Future ecological worker	2 0 x 10^{8}	2 0 x 10^{-4}	7 0 x 10^{8}	3 0 x 10^{4}
Future open space use	6 0 x 10^{9}	3 0 x 10^{-}	3 0 x 10^{7}	4 0 x 10^{4}
Future construction worker	3 0 x 10^{-8}	3 0 x 10^{3}	1 0 x 10^{7}	2 0 x 10^{2}

The Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions (EPA 1991a) states that for sites where the cumulative risk to an individual based on RME for both current and future land use is less than 1 0 x 10^{-4} action is generally not warranted but may be warranted if a chemical specific standard that defines acceptable risk is violated Chemical specific standards have been calculated for OU 2 and are further discussed as remediation goals in the following subsection

I 5 5 REMEDIATION GOALS

As discussed in the Risk Assessment Guidance Document Part B (EPA 1991b) remediation goals are long term targets to use during analysis and selection of remedial alternatives Ideally such goals if achieved should comply with ARARs and result in residual risks that fully satisfy the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requirements for protection of human health and the environment

Chemical specific remediation goals are concentration goals for individual chemicals for specific medium and land use combinations at Comprehensive Environmental Response Compensation and Liability Act

(CERCLA) sites There are two general sources of chemical specific remediation goals (1) concentrations based on ARARs and TBC standards and (2) risk based calculations that set concentration limits using carcinogenic and/or noncarcinogenic toxicity values under specific exposure conditions The remediation goals for COCs for surface soil were originally identified in Technical Memorandum No 1 (DOE 1995a) and modified based on the HHRA

Table I 5 3 presents the remediation goals used to screen and calculate contaminated surface soil volumes and evaluate remedial alternatives for this IM/IRA The maximum contaminant concentration is presented for comparison against the remediation goals to determine which contaminants warrant further evaluation in the 903 Pad and Windblown Soils IM/IRA decision document Remediation goals were calculated for an office worker exposure scenario and an open space exposure scenario These exposure scenarios were recommended for use at RFETS by the RFFSUWG The office worker exposure scenario is applied at the 903 Pad and Lip Area per the working groups recommendations The open space exposure scenario is applied in the buffer zone area also per these recommendations Appendix B contains the calculations for the remediation goals presented in Table I 5 3 and estimated surface soil volumes

The maximum detected concentrations for Aroclor 1254 Aroclor 1260 Bis(2-ethylhexyl)phthalate and Chromium III were all below remediation goals Therefore remediation of surface soils is not necessary for these chemicals The maximum concentrations of Pu 239/240 and Am 241 exceed their respective remediation goals in the 903 Pad Lip Area Therefore remediation of surface soils for these radionuclides is indicated in this area The maximum concentrations of Pu 239/240 and Am 241 do not exceed their respective remediation goals in the buffer zone therefore remediation is not necessary in the buffer zone

I 5 5 1 Chemical Specific ARARs or TBCs

Chemical specific ARARs and TBCs for surface soil that establish protective levels based on protection to human health and/or the environment exist for PCBs (Aroclor 1254 and Aroclor 1260) and radionuclides Cleanup standards for soils contaminated with PCBs are regulated under the Toxic Substances Control Act (TSCA) The TSCA requirements for cleaning up PCB spills are considered TBC criteria Although PCB spills that occurred prior to May 4 1987 are excluded from 40 CFR 761 Subpart G (the EPA PCB Spill Cleanup Policy) DOE believes that the cleanup targets in the policy are protective of human health and the environment The policy establishes a soil cleanup target of 25 parts per million (ppm) PCBs by weight in restricted areas The DOE believes that the 903 Pad and associated windblown soils meet the definition of a restricted area, as they are located within an industrial site where access is limited and separated by over 0 1 kilometers from any residential or commercial area, as defined in 40 CFR Section 761 123

The TBC criteria identified for plutonium and americium in Technical Memorandum No 1 (DOE 1995a) were based on an annual radiation dose limit of 100 mrem effective dose equivalent using the office worker exposure scenario and exposure pathways outlined in the Programmatic Risk Based Preliminary Remediation Goals (DOE 1994) and the RME parameters agreed to by the EPA CDPHE and the DOE The equation was modified to use dose millirem (mrem) instead of a target risk level in the numerator and a dose equivalent factor (mrem/microcurie [μCurie]) instead of a cancer slope factor in the denominator The DOE Order 5400 5 (DOE 1991) restricts the offsite radiation dose to members of the public to a 100 mrem effective dose equivalent per year Following completion of the HHRA the TBC criterion was modified to reflect site specific conditions and exposure parameters used in the HHRA These modifications included revising the exposure scenario using an office worker exposure scenario inside the IA of the RFETS and an open space exposure scenario outside the IA

The 100 mrem effective dose equivalent presented in DOE Order 5400 5 was intended to apply to doses to the public resulting from all exposure modes from all DOE routine activities To limit the dose resulting from a single source and ensure that the standard was protective of human health and the environment the TBC criterion was further revised to reflect an annual radiation dose limit of 15 mrem effective dose equivalent In addition the 15 mrem remediation goal is consistent with the proposed Nuclear Regulatory Commission (NRC) radiological criteria for decommissioning (59 FR 43200 August 1994)

I 5 5 2 Risk Based Remediation Goals

Because no ARAR or TBC criteria were identified for surface soil containing bis(2 ethylhexyl)phthalate and chromium III risk based remediation goals were calculated in Technical Memorandum No 1 (DOE 1995a) These remediation goals were modified to reflect site specific conditions and exposure parameters used in the HHRA

I 5 5 3 Summary of Results

A comparison of the maximum contaminant values and the remediation goals indicate that both Pu 239/240 and Am 241 exceed the remediation goals in the 903 Pad Lip Area based on a 15 mrem effective dose equivalent and warrant further consideration in the 903 Pad and Windblown Soils Area IM/IRA decision document

Table I 5 3
Remediation Goals

Chemicals of Concern	Maximum Detected Concentration[b]		Regulatory Based Remediation Goal	Risk Based/Dose Remediation Goals[a]			
				Office Worker		Open Space	
	Inside 903 Pad Lip Area	Outside 903 Pad Lip Area		Risk Based	15 mrem	Risk Based	15 mrem
Aroclor 1254 (mg/kg)	9 70 x 10	2 20 x 10	2 5 x 10	NA	NA	NA	NA
Aroclor 1260 (mg/kg)	6 60 x 10	2 20 x 10	2 5 x 10'	NA	NA	NA	NA
Bis(2 ethylhexyl) phthalate (mg/kg)	5 10 x 10^{1}	4 5 x 10		4 09 x 10^{2}	NA	1 28 x 10^{3}	NA
Chromium III (mg/kg)	3 21 x 10^{1}	2 95 x 10^{1}		1 00 x 10^{6}	NA	1 00 x 10^{6}	NA
Plutonium 239/ 240 (pCi/g)	1 10 x 10^{4}	7 3 x 10^{3}			1 64 x 10^{3}		1 61 x 10
Americium 241 (pCi/g)	2 70 x 10^{2}	1 64 x 10^{2}			1 42 x 10^{2}		1 43 x 10^{3}

[a] Remediation goals based on RME factors
[b] Maximum concentration originates from RFI/RI for OU 2
[c] Toxic Substances Control Act (TSCA) (see 40 CFR 761 120 and 761 125)
[d] NA–Not applicable because remediation goal is either regulatory based or risk based and therefore is not included

I 6 ESTIMATION OF AREAS REQUIRING REMEDIATION BASED ON AN ANNUAL DOSE OF RADIOACTIVITY

Surface soil contamination levels based on RFI/RI data were compared against radiation dose based remediation goals to establish the areal extent of contaminated soils requiring remediation Figure I 6 1 identifies those areas within the 903 Pad and Windblown Soils Area that exceed the remediation goals Surface soils outside of IHSS 155 including the East Spray Fields (IHSSs 261 2 and 261 3) do not require remediation to achieve a 15 mrem effective dose equivalent based on the open space exposure scenario Similarly surface soils in IHSS 183 the Gas Detoxification Site do not require remediation to achieve the remediation goals

Within IHSS 155 approximately 3 1 acres outside of the 903 Pad Drum Storage Site require remediation to achieve the remediation goals based upon the office worker exposure scenario as shown in Appendix B The results of the RFI/RI indicate that outside of the 903 Pad Drum Storage Site over 95 percent of the Pu 239/240 and Am 241 contamination is confined to the upper 20 cm of soils and soils at the surface exhibit the highest contamination levels Therefore a 20 cm depth was assumed as the extent to which soils will be remediated At this depth a total volume of 3 280 cubic yards of contaminated surface soils require remediation for the 3 1 acres exceeding the remediation goal

Because there is no evidence of surficial soils being remediated before placement of the clean fill and asphalt cap it is believed that soils below the fill are contaminated above remediation goals The 903 Pad Drum Storage Site will be remediated to prevent potential future surface erosion and transport of contaminated soils that are currently beneath the pad The volume of contaminated soil beneath the 903 Pad as well as the volume of the asphalt pad were examined During past remedial actions at the 903 Pad Drum Storage Site approximately 20 cm of clean fill and a layer of asphalt were placed over contaminated soils Although the 20 cm of fill may not be thoroughly contaminated the entire volume is suspect The 20 cm of soil under the fill is assumed to contain contamination above remediation goals The total volume of contaminated material to be remediated from under the 903 Pad is estimated at 8 570 cubic yards and includes the volume of the asphalt cap The total estimated volume of contaminated surface soil requiring remediation is 11 850 cubic yards This volume estimate was rounded up to 12 000 cubic yards for use in the evaluation of remediation process options and alternatives

I 7 IM/IRA ASSUMPTIONS

The following assumptions have been made in preparing this IM/IRA

All wastes associated with the surface soil remediation are nonhazardous low level radioactive wastes Soils will be characterized to assure that they are only low level radioactive waste

The remediation goals as outlined in this document for the office worker and open space exposure scenarios are approved for use

Concentrations of Am 241 and Pu 239/240 in the soil under the 903 Pad Drum Storage Site exceed the office worker remediation goals and require remediation Soils will be surveyed to assure that only soils exceeding remediation goals are remediated All soils excavated will be characterized to assure that no hazardous chemicals are present

Postremediation surveys will be performed on all areas requiring remediation to assure that remediation goals have been met Postremediation survey results will show that the remediation goals for Pu 239 and Am 241 are not exceeded

IHSS 183 the Gas Detoxification Building will be removed during the remediation activities of the 903 Pad Lip Area and the 903 Pad Drum Storage Site

Remediation of groundwater and subsurface soils is not within the scope of this surface soil IM/IRA decision document

Surficial soils containing Am 241 and Pu 239/240 in the 903 Pad and Lip Area exceed the office worker remediation goals and require remediation A surficial soil survey will be performed before remediation proceeds to assure that the remediation goals are exceeded Only Soils exceeding remediation goals will be remediated

Surficial soils outside of the IA fence (in the buffer zone) will be surveyed to delineate areas that may exceed remediation goals This IM/IRA assumes that not soils in the buffer zone exceed remediation goals

Due to surveying of soils part of the 12 000 cubic yards of material will be deemed below remediation goals This decision document assumes that all 12 000 cubic yards needs to be remediated

Part II
Remedial Alternatives Evaluation

II 1 GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS

This section presents the general response actions (GRAs) remedial technologies and potential process options that were identified and initially screened as part of the surface soils evaluation presented in Technical Memorandum 2 for OU2 (DOE 1995c) GRAs were identified to satisfy the remedial action objectives established for OU2 These GRAs represent a full range of potential actions to ensure that a reasonable range of remedial alternatives have been evaluated A general description of each GRA is provided below

No Further Action Required by CERCLA as a benchmark for comparison against other remedial action alternatives No direct action will be taken to alter the existing situation Long term air surface water and radiological monitoring of site conditions would be performed

Institutional Controls Refers to controls based on legal and/or management policies which minimize public exposure to potential contaminants The land use would be legally restricted by zoning provisions and/or modification to the deed and site access would be limited with fencing Long term air surface water and radiological monitoring would be conducted

Containment Consists of those actions which would minimize or prevent migration of contaminants by wind dispersion or surface water erosion mechanisms

In Situ Treatment In situ treatment refers to treatment of contaminants in place In situ treatment actions would remove detoxify and/or immobilize contaminants using chemical thermal physical or biological technologies

Excavation and Disposal Includes actions such as soil excavation which are used to remove and/or consolidate contaminated media Also includes transportation and disposal of radioactive wastes at facilities such as landfills corrective action management units (CAMUs) and vaults

Ex Situ Treatment This action is similar to in situ actions with the exception that the contaminated media are extracted or removed prior to treatment. Ex situ action separate or concentrate detoxify or immobilize contaminants using chemical thermal physical or biological technologies

II 1 1 IDENTIFICATION OF TECHNOLOGIES AND PROCESS OPTIONS

Remediation technologies and process options were identified to address contaminated surface soil at the 903 Pad and Windblown Soils Area A comprehensive list of remediation technologies and process options were initially developed for the OU 2 CMS/FS (EG&G 1994) Resources consulted to compile the comprehensive list of technologies (ES 1994) included

EPA and DOE guidance documents

Technical publications journals and proceedings

Computerized remediation and waste treatment databases including EPA s Vendor Information System for Innovative Treatment Technologies (VISITT) Risk Reduction Environmental Laboratory (RREL) Treatability Database and Alternative Treatment Technology Information Center (ATTIC)

Existing RFETS documents including treatability studies and IM/IRA reports

Information provided in the comprehensive list of technologies and additional EPA and DOE guidance documents was used to perform an initial screening of technologies and process options based on OU 2 specific conditions

II 1 2 SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

The list of technologies and process options was screened against established criteria for applicability and implementability The goal of the initial screening process was to eliminate those technologies and/or process options that could not be implemented because of site specific factors This step reduced the number of remedial technologies and process options for consideration in the development of remedial alternatives Process options were initially screened and evaluated under the assumption that they would be implemented as the primary remedial treatment process Therefore several process options were not retained after screening because they were only applicable as a secondary treatment or a component of a potential remedial alternative

The second screenmg was a fatal flaw analysis based solely on technical implementability This stage of screening required the review of site characteristics and specific information for each process option to identify any factor that would prevent the technology or process option from being implemented at the 903 Pad and Windblown Soils Area for surface soil remediation Factors affecting technical implementability that were considered during the fatal flaw analysis included

Characteristic contaminant properties
COC concentrations
Horizontal and vertical extent of contamination
Surface topography

If any factor or combination of factors that would prevent a process option from being implemented was identified that process option was eliminated from further consideration and the reason was documented The process options remaining after the initial screen were evaluated based on potential effectiveness administrative implementability and relative cost Specific factors considered within each of these categories include the following

Effectiveness.

Potential effectiveness of process options in handling anticipated areas or volumes of contaminated media

Potential effectiveness of process options in meeting the C/RAOs

Potential impacts to human health and the environment due to process options during construction and implementation

Proven applicability and reliability of process options given current understanding of the site specific conditions and contaminant concentrations

Implementability.

Availability of required treatment storage and disposal (TSD) services for process options

Ability to obtain necessary approvals and permits for process options

Availability of required equipment and skilled workers for implementation of process options

Constructability of process options including site specific constraints such as access topography time and regulatory commitments

Relative Cost.

The cost estimates were developed using several sources Horizontal barrier process options primarily used RFETS site specific data developed for cover alternatives at OU 4 The disposal and treatment process options primarily were referenced from the RFETS Environmental Restoration Management Cost Estimating Manual Document No RFP/ERM 94 00009 (Parsons ES & Rust 1994) Where additional information was required the EPA Remediation Technologies Screening Matrix and Reference Guide Document No EPA 542 B 93 005 (EPA 1993) was used Estimates for disposal and transportation also used the detailed estimates developed for OU 4

The accuracy of the cost estimates at this screening step was plus 100 percent or minus 50 percent Estimates are intended to be used only for comparisons of one process option to another within a technology type

The results of the screening process are presented in Figure II 1 1 Based on the screening process the most appropriate process options were carried forward and developed into specific remedial alternatives for the 903 Pad and Windblown Soils Area The remedial alternatives carried forward into the detailed analysis of alternatives included

No further action
Institutional controls
Enhanced vegetative cover
Excavation and onsite disposal
Ex Situ treatment via stabilization with return to excavation

The following section provides an engineering description of these alternatives

Surface Soil General Response Action	Remedial Technology	Process Options	Effectiveness	Implementability	Cost
No Further Action	None	Not Applicable	Does ot achieve C/RAOs	Difficult regul tory/community cceptance	None
Institutional Controls	Access Restrictions	Fencing Security tc	May achieve C/RAOs Effectiveness depends on continued futur implementation Does not reduce contamination	Difficult regulatory/community acceptance	Low capital low O&M
	Land Use Restrictions	Deed Restrictions	May achieve C/RAOs. Effectiveness depends on continued future mplementation Does not reduce contamination.	Difficult regulatory/community cceptance	Low capital low O&M
		Zoning Restriction	May achieve C/RAOs Effectiveness depends on continued future mplementation Does not reduce contamination.	Difficult regulatory/community acceptance	Low capital low O&M
	Monitoring	Fugitive Dust Monitoring	Effective monitoring method	Easily implemented	Low capital, low O&M
Containment	Horizontal Barriers	Vegetative Cover	May achieve C/RAOs with estrictions on future land use	Easily implemented	Low capital med O&M.
		Asphalt-Based Cover	May achieve C/RAOs with restrictions on future land use Eliminated due to long-term effectiveness and high maintenance requirements	Easily implemented	Low capital med O&M
		Compacted-Clay Cover	May achieve C/RAOs with restrictions on future land use Eliminated because may crack in semi-arid environment.	Difficult implementation	High apital med O&M
		Multi-Layer Cover	May achieve C/RAOs with restrictions on future land use	Easily implemented Long implementation chedule	High capital med O&M Eliminated because cost prohibitive
In situ Treatment	Solidification/ Stabilization	Stabilization, Slurry Injection Solidification Cementation, Encapsulation	Effectiveness and reliability evaluations require treatability study Eliminated long-term effectiveness suspect and quality assurance of solidified product difficult.	Average implementability	Insufficient data

LEGEND

Technology or process option eliminated from further evaluation.

Notes Cost evaluation is relative only within remedial technology groupings

(Continued next page)

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Figure (Sheet of 3)

Operable Unit No.
Interim Measure/Interim Remedial Action
Results of Screening Process

Surface Soil General Response Action	Remedial Technology	Process Options	Effectiveness	Implementability	Cost
Removal	Excavation	Soil Excavation	Appe rs t meet C/RAOs Would require con rols t prevent mobilization f contaminant	Easily mplemen ed	Low capital low O&M
	Short Distance Transport	Conveyor System	Effective reduces mobil ty of contaminants Would require controls to prevent mobilization of contaminants	Easily implemented	High capital med O&M
		Slurry Pipeline	Effective reduces mobility of contaminants Would requir controls prevent mobilization of contaminants	Easily mplemented	High capital high O&M
	Long Distance Transport	Truck/Rail Hauling	Effective reduces mobility of contaminants Would require cont ols t prevent mobilization of contaminants	Easily implemented. DOT permits m y be required	High capital low O&M
	Offsite Storage/Disposal	Landfill/TSD Facility	Effective reduces mobility of contaminants Would require controls to prevent mobilization of contaminants	Easily implemented Risk to public sts during transpo tation.	High capital low O&M Eliminated because cost prohibitive
	Onsite Storage/Disposal	Disposal Vault	Effective reduces mobility of contaminants Would require controls t prevent mobilization of contaminants	Difficult implementation, would require permits and construction of onsite TSD facility	High capital, low O&M Eliminated because cost prohibitive
		Container Storage	Effective reduces mobility of contaminants Would require controls t prevent mobilization of contaminants Eliminated because not long-term solution	Difficult implementation RFETS has permitted storage reas however capacity may be lim ted Long-t rm storage may not be acceptable	Low capital med O&M
		Permitted Landfill	Effective reduces mobility of contaminants Would require controls to prevent mobilization of contaminants	Difficult implementation would equire permits and construction of onsite TSD facility	High capital med O&M

LEGEND

[hatched box] Technology or process option eliminated from further evaluation

(Continued next page)

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Figure (Sheet of 3)

Operable Unit No. 2
Interim Measure/Interim Remedial Action
Results of Screening Process

CMSF804B PMS AOE ASK4OU2 rep 9/21/95

Surface Soil General Response Action	Remedial Technology	Process Options	Effectiveness	Implementability	Cost*
Ex situ Treatment	Chemical/Physical	Chemical Red/Ox (1)	Effectiveness nd eliability evaluations require reatability study El minated because not considered stand alone process ption and must be used in treatment train	Insufficient data ailable to e h p ocess option	Insufficient data
Ex situ Treatment	Chemical/Physical	Soil Washing (2)	Effectiveness and reliability evaluations require treatability study Current treatability work looks promising. Generates secondary wastes Eliminated because not considered stand alone process option, and must be used in treatment rain.	Average implementation	Med capital med O&M
Ex situ Treatment	Chemical/Physical	Electrokinetics	Effectiveness and reliability evaluations require treatability study Eliminated because not considered stand alone process option and must be used in treatment train.	Difficult implementation, innovative technology	High capital med O&M
Ex situ Treatment	Biological	Biological Leaching (3)	Effectiveness and reliability evaluations require reatability study Work at RFETS in early stages	Eliminated because nsufficient data t dete mine if this process option implementable	Insufficient data
Ex situ Treatment	Solidification/Stabilization	Stabilization (4)	Effectiveness and reliability evaluations require treatability study Effectiveness for heavy metals is established	Average implementability TSD services f r heavy metals may be applicable	Insufficient data.
Ex situ Treatment	Solidification/Stabilization	Encapsulation	Effective appears to meet C/RAOs Would require controls t prevent mobilization of contaminants Eliminated because it is subset of tabilization	Average implementability	Medium capital med O&M
Ex situ Treatment	Solidification/Stabilization	Cementation	Average effectiveness appears to meet C/RAOs Would require controls to prevent mobilization of contaminants Subset of stabilization Eliminated because it is subset of stabilization.	Easily implemented	Low capital med O&M
Ex situ Treatment	Solidification/Stabilization	Vitrification (Plasma Arc, Slagging Furnace Joule-Heated Glass Melter)	Effective appears to meet C/RAOs Would require controls to prevent mobilization of contaminants Requires treatability test.	Eliminated because of difficult implemention from cessive energy and highly trained personnel equ ements	High capital med-high O&M

NOTE Process options are components of the following treatment systems or studies.

(1) Aqueous Biphase Separation (ABS)
(2) TRU Clean®
Gravity/Flotation/Chemical Enhancement (NRT Study)
Chemically Enhanced Steam Stripping (CESS)
Chelating Aquents (LANL Study)
(3) MBX Study (Lockheed)
(4) WES-PHIX Process

LEGEND

[hatched box] Technology or process option eliminated from further evaluation.

Notes Cost evaluation is relative only within remedial technology groupings

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Figure (Sheet 3 of 3)

Operable Unit No. 2
Interim Measure/Interim Remedial Action
Results of Screening Process

II 2 DETAILED DESCRIPTIONS OF REMEDIAL ALTERNATIVES

For each of the remedial alternatives the selected primary process components are listed and described regarding size and configuration of equipment needed process rates and remedial durations expected constructability issues and permitting Estimated times for completion do not include preremediation management or mobilization or demobilization The information presented in the following subsections will provide the technical basis for the detailed analysis of alternatives (DAA)

II 2 1 ALTERNATIVE 1 NO FURTHER ACTION

The no further action alternative would involve no additional remedial activities or institutional controls No process options require development or evaluation for this alternative The no further action alternative is required as a basis for comparison with the other remedial alternatives

Remedial activities associated with this alternative include monitoring for radioactive airborne particulates ambient gamma field monitoring and monitoring of radioactivity in surface water Radiological monitoring would be conducted to evaluate potential contaminant migration from the site via air dispersion pathways upward migration to the surface via biota transport and surface water runoff Monitoring activities would be reviewed every 5 years in accordance with CERCLA

Monitoring for radioactive particulates and surface soil hot spots would include both radioactive airborne particulate and ambient gamma field monitoring The RFETS currently conducts both types of monitoring on a regular basis Monitoring would continue for at least 30 years or until it is determined that remediation goals for surface soil have been achieved

Monitoring for radioactive material present in surface water would be required to determine if contaminants were migrating via surface water runoff and having an adverse impact on South Walnut Creek or Woman Creek The RFETS currently collects surface water samples as part of the sitewide environmental protection program The surface water runoff monitoring could be implemented as part of the site wide program with minimal effort and would continue for a 30 year period pending results of the 5 year CERCLA reviews

II 2 2 ALTERNATIVE 2 INSTITUTIONAL CONTROLS

Institutional controls reduce potential exposures to site contaminants through administrative actions and access restrictions Administrative actions include deed restrictions to control future land use and long term monitoring to determine whether contaminants are migrating Deed restrictions impose legally enforceable controls to prevent development excavation or construction on the land to prevent contact with and mobilization of contamination Access restrictions include fencing and warning signs Specific institutional controls are described below

II 2 2 1 Access Restrictions

A 6 foot high fence with warning signs would be installed around the area with surface soil concentrations of Pu 239/240 and Am 241 above the remediation goals Approximately 4 250 linear feet would be required around the 903 Pad Lip Area It is expected that the fencing would be installed within several months from approval of the IM/IRA decision document For cost purposes it is assumed that access restrictions would be needed for 30 years

II 2 2 2 Deed Restrictions

Deed restrictions would be imposed to ensure that excavation construction or other high risk activities did not oc ur within controlled areas By imposing deed restrictions on the site contact with contaminated soils and spreading of contaminated surface soils due to disturbance would be significantly reduced The deed restrictions would remain in place until it was determined that unrestricted use of OU 2 surface soils was deemed acceptable A permanent notation would be made in the legal land record of the local governmental agency stating that Pu 239/240 and Am 241 contamination is present at the site

II 2 2 3 Radiological Monitoring

Monitoring would be performed to ensure that r dioactive airborne particulates ambient gamma field le and surface water runoff from the site are not above the determined action levels Monitoring would be conducted as part of the RFETS site wide monitoring and would continue for at least 30 years The monitoring activities would be reviewed every 5 years in accordance with CERCLA Monitoring needs would be similar for all institutional control options and for the no further action option

II 2 3 ALTERNATIVE 3 ENHANCED VEGETATIVE COVER

This alternative would cover the contaminated soils in place in the 903 Pad Drum Storage Area. The contaminated soils from the 903 Pad Lip Area would be consolidated beneath the cover in the 903 Pad Drum Storage Area The site would be cleared of debris and vegetation then graded prior to the placement of the enhanced vegetated cover A conceptual diagram of this remedial alternative i resented in Figure II 2 1

From the bottom to the top the cover would consist of a riprap layer placed directly on the final grade a gravel layer a geotextile fabric a layer of clean imported backfill and a layer of topsoil The topsoil would be seeded with native vegetation Figure II 2 2 presents a possible cross section of the enhanced vegetative cover

Water and wind erosion would be controlled by the vegetation The vegetation would interrupt water flow paths reduce flow velocities and provide surface irregularities for sediment deposition The vegetation would also enhance soil stability The entire cover system would reduce the potential for direct contact with the contaminated soils that are currently at the surface

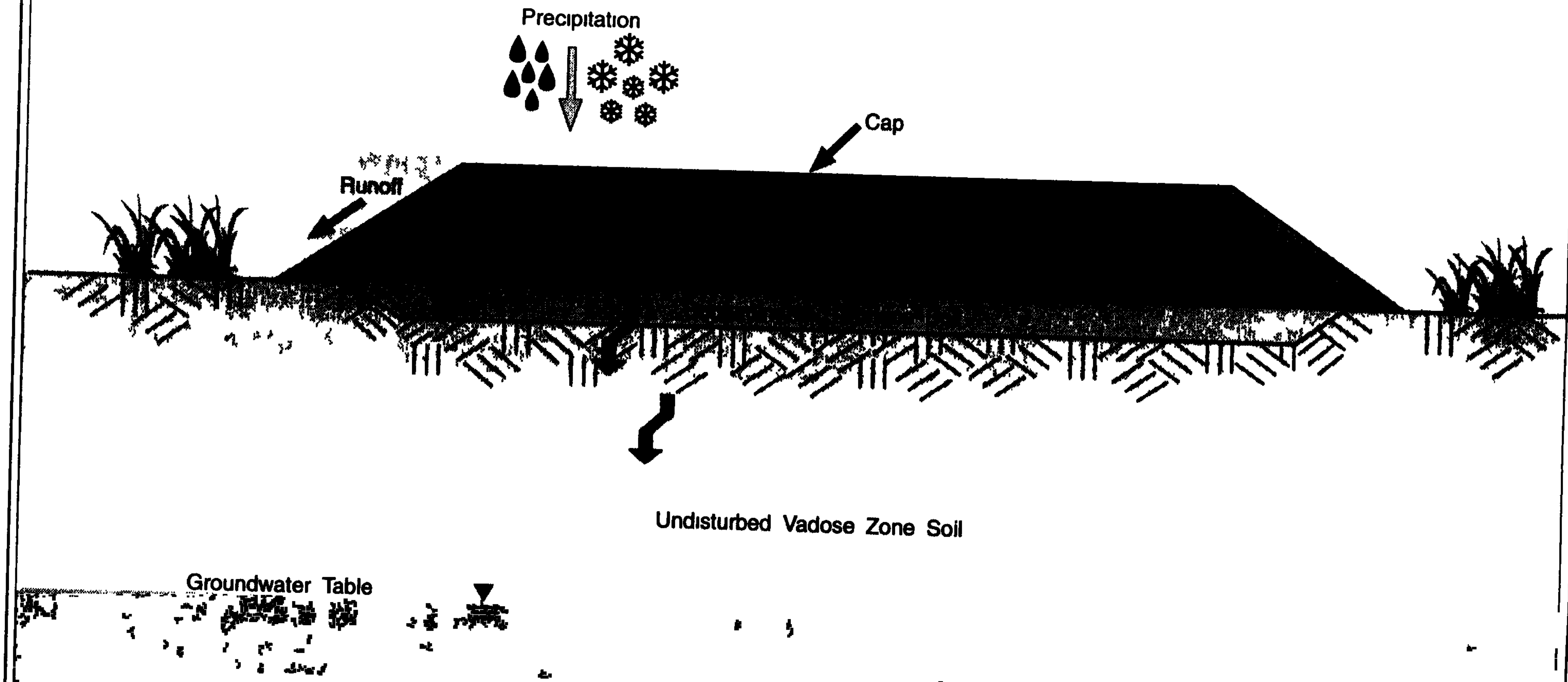
It is believed that macropore flow lateral discontinuity and biological activities (i e burrowing and/or soil mixing by earthworms rodents and ants) have contributed to the mobilization of contaminants in shallow soils at the 903 Pad and Windblown Soils Area The incorporation of the riprap and gravel layers and the geotextile fabric is expected to control biological vectors and reduce precipitation infiltration

Construction activities to implement an enhanced vegetative cover would include clearing filling and grading material placement and revegetation of the cover area as well as surrounding areas affected by the construction operations This alternative could be implemented within a 4 month period The following subsections describe the Alternative 3 components

II 2 3 1 Site Preparation and Grading

Site preparation would include clearing operations to remove oversized debris rocks and any other obstacles that would interfere with the placement of the cover materials and the final design grade Approximately 3 200 cubic yards of plutonium contaminated hillside soils would be removed placed and graded over the asphalt pad Standard earthmoving equipment such as bulldozers scrapers loaders and dump trucks would be used for these activities A water truck would be used to control dust Clearing and grading operations for the 3 1 acre site would require approximately 5 days

Compaction beyond that provided by normal operation of the earthmoving equipment should not be required The cover would have a slight grade to provide positive drainage without causing soil erosion To the maximum extent practical the final grade would match the existing relatively flat ground surface Grading operations would use standard earthmoving equipment such as bulldozers loaders and if clean fill is imported dump trucks



Note
Contaminated surface soil is capped in place

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Figure II 2 1

Operable Unit No 2
Interim Measure/Interim Remedial Action
Alternative 3
Enhanced Vegetative Cover

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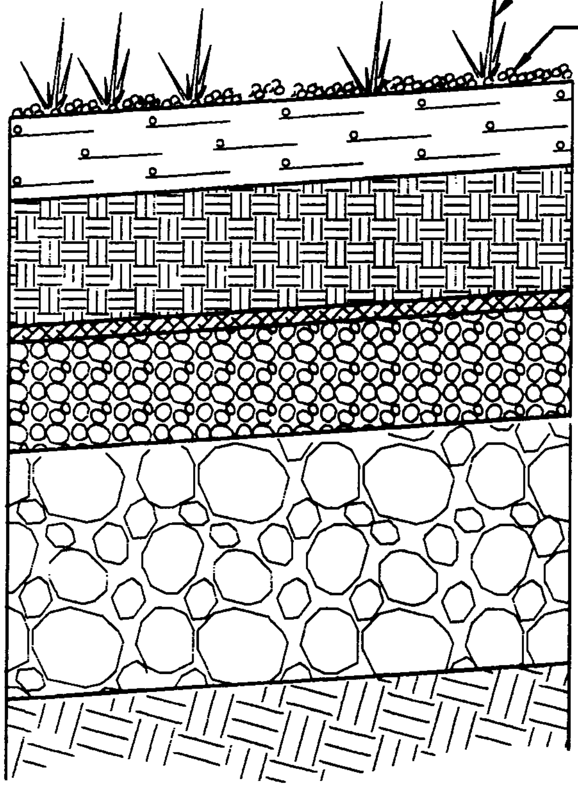

NOT TO SCALE

NOTE

1 THIS SKETCH REPRESENTS PRELIMINARY DESIGN CONCEPTS IF SELECTED THE FINAL CONFIGURATION WILL BE DEVELOPED ON DESIGN DRAWINGS

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Figure II 2 2

Operable Unit No 2
Interim Measure/ Interim Remedial Action
Enhanced Vegetative Cover Cross Section

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The estimated time required to remove and transport contaminated surface soils from the 3 1 acre area to the 90^ Pad is approximately 5 days

II 2 3 2 Installation of Enhanced Vegetative Cover

Construction of the enhanced vegetative cover would begin with placement of the riprap and gravel layers These layers would be sized to create a capillary break as well as a biotic barrier These layers would then be covered with a geotextile fabric and topped with 18 inches of clean imported fill and 12 inches of topsoil material

The underlying riprap and gravel layers will serve multiple functions First they will provide a biotic barrier against root growth and animal migration Root penetration will stop when the roots encounter repeated air voids in the gravel layer The burrowing mammal species most common to the RFETS area are prairie dogs and badgers Neither of these species will burrow through riprap or gravel Therefore the layers of riprap and gravel will deter the animals from burrowing down into the contaminated surface soils

The riprap and gravel layers also will provide a significant increase in pore size in comparison to the relatively fine grained soils above them thereby encouraging a capillary break The capillary break will cause moisture to be retained in the upper fine grained soils which have a higher surface tension and a negative pressure within the pores of the fine grained soil matrix Significant amounts of moisture will only percolate down into the relatively large voids of the riprap and gravel layers when the overlying fine grained soils become saturated While the subgrade underlying the riprap and gravel layers would not be a completely impermeable layer it would be a tightly compacted surface This would encourage lateral drainage within the riprap and gravel layers and reduce the amount of moisture infiltration into the contaminated soils It is also anticipated that the riprap and gravel layers will hinder the upward movement of worms through the contaminated soils and into the topsoil portion of the enhanced vegetative cover

Geotextile fabric would serve dual functions in the cover First it would provide the filtering necessary to segregate the overlying fine grained soils that support vegetation from the underlying gravel layer This filtering action will maintain the void spaces between the two earthen materials creating the capillary break The geotextile material will have an appropriate mesh size to maintain the required filtering between the clean backfill and gravel layers Second the geotextile will serve as a biotic barrier against plant root growth and earthworms

Vegetation will play a critical role in the enhanced vegetative cover Its soil binding properties and the physical cover it provides will be the major protection against wind and water erosion of the cover In addition vegetation removes moisture through the transpiration process This coupled with the natural evaporation process forms a moisture removal process called evapotranspiration (ET) The estimated ET rate in the RFETS region exceeds the average annual precipitation by as much as three times Therefore an enhanced vegetative cover is expected to remove the majority of the precipitation percolation before infiltration would occur

The vegetation species would be chosen to blend with the surrounding species as well as their ability to withstand drought and erosive forces The species chosen would include cool season grasses which will come out of dormancy early in the spring thereby allowing the ET process to begin early in the season Some early to establish species would also be included to allow for early protection of the topsoil from wind and water erosion Seeding operations would be performed with either a hydroseeder or a drill seeder

The topsoil level will include a specified proportion of gravel This coarser material will help protect the topsoil against erosion by forming an armoring layer The topsoil will also have a specific pH range minimal soluble salt content specific gradation and a proper balance of nutrients (e g nitrogen phosphorus and potassium) to encourage plant growth

The estimated time to install the enhanced vegetative cover was based on an 8 hour work day using 18 cubic yard haul trucks (15 cubic yards assumed capacity) and assumes that a portion of the materials will be stockpiled onsite prior to grading operations Some schedule overlap of the placement of materials is expected For example the placement of clean fill can begin when a significant area of riprap gravel and geotextile has been placed

II 2 3 3 Operation and Maintenance

A moderate level of long term operation and maintenance (O&M) would be required with the enhanced vegetative cover alternative Periodic visual observation would be used to detect any areas requiring repairs Maintenance of the enhanced vegetative cover is expected to be fairly intensive in the short term but long term maintenance is expected to be minimal Short term maintenance would possibly include mulching to retain the seeding on the hillside re seeding of areas and control of weeds Long term maintenance would include revegetation and repairs of the cover due to excessive erosion or rodent and animal intrusion

II 2 3 4 Site Restoration

Some portion of the surrounding terrain will be affected by construction operations These areas would be revegetated or at a minimum restored to their original condition Standard seeding equipment and materials and standard earthmoving equipment would be used for site restoration

II 2 3 5 Institutional Actions

Deed restrictions and access restrictions for this alternative would be similar to those implemented for Alternative 2 as discussed in Section II 2 2 2 The cover is expected to occupy approximately 4 acres Section II 2 2 3 also describes the radiological monitoring

II 2 4 ALTERNATIVE 4 EXCAVATION AND DISPOSAL

This alternative would involve the excavation of soils determined to be contaminated in excess of the remediation goals continued radiological monitoring of the locations during excavation and final sampling and analysis to confirm that the surface soils contaminated above remediation goals were completely removed Transportation and disposal actions would isolate the contaminants from humans and the environment Site restoration would be accomplished with the use of imported clean backfill and subsequent seeding of the exposed soils The estimated duration for this alternative is 13 weeks Figure II 2 3 presents the conceptual diagram for this remedial alternative The following subsections detail the Alternative 4 components

II 2 4 1 Site Preparation

Site preparation would include a survey of the site to determine the boundaries of the excavation Such a survey would include a final estimate of the quantities to be removed to determine a basis for design and selection of excavation equipment Preparations for haul routes laydown areas and staging areas would be made Any required boundaries of an exclusion zone and the location of the decontamination area would also be determined Prior to the initial breaking of ground RFETS would confirm the location of any utilities that run through or near the site

II 2 4 2 Excavation and Transportation

Excavation would consist of the removal of contaminated surface soils using such equipment as scrapers bulldozers front end loaders off road haul trucks and water trucks for dust suppression The excavated soil would be transported to the onsite (that is within the boundaries of the RFETS) waste management facility in bulk for disposal Operations at the onsite waste management facility would include accounting for the volume of soils being delivered and verification that the surface soil meets the waste acceptance criteria of the onsite disposal cell

Dust suppression would consist of water addition to the surface soil during excavation operations and during project shutdown in high wind conditions Water trucks with spray bars or spray applied foams will be used to minimize dust production if needed Dust will be controlled during the project to the extent that no visible dust will be allowed Radioactive airborne particulates would be monitored during excavation operations to assess the effectiveness of the dust control measures and to ensure that exposures to workers are as low as reasonably achievable (ALARA)

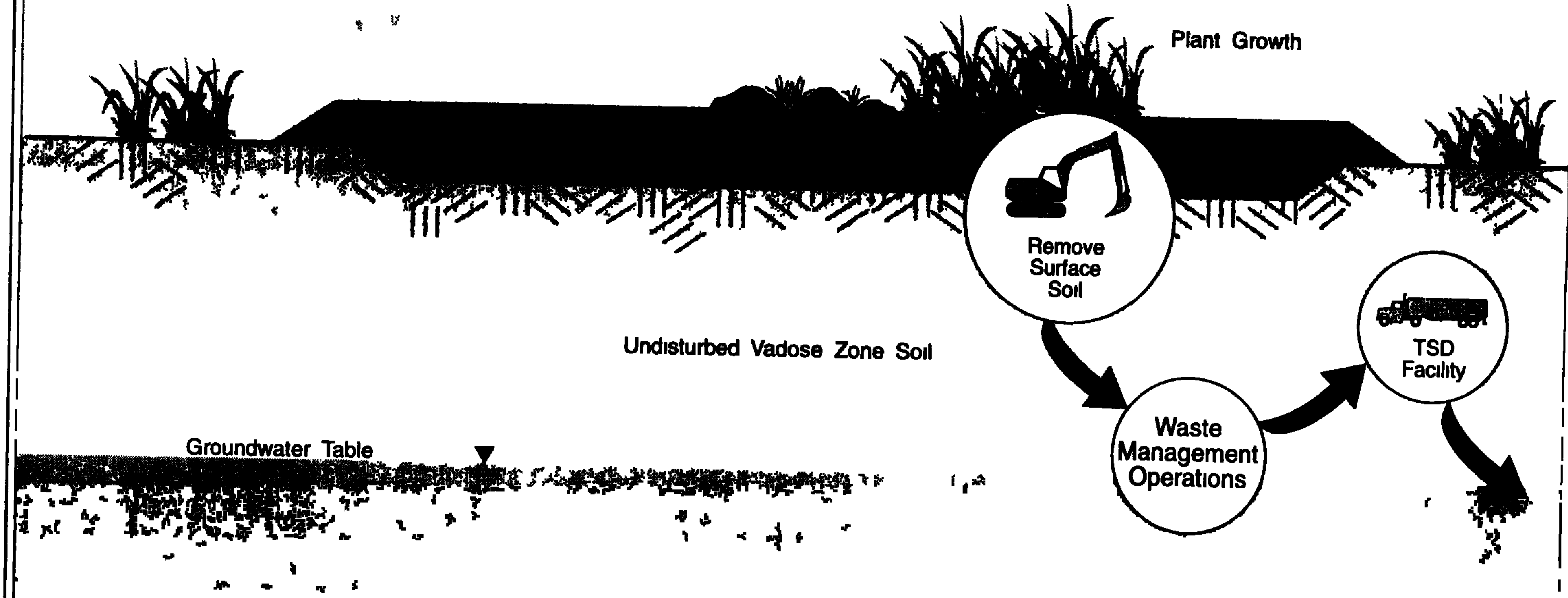
Truck loading rates rather than excavation rates will control the duration of the excavation and disposal alternative Truck loading rates are limited primarily by health and safety issues regarding inhalation of radioactive airborne particulates during the loading of the trucks A healthy and safety plan will be followed during excavation activities

Personal monitoring operations would be conducted during the start up of excavation to determine if Occupational Safety and Health Administration (OSHA) Level D personal protective equipment is appropriate for the job Radiological control requirements which are not regulated under OSHA will be addressed in the radiological work permit The safety level will impact the productivity rates of the excavation operations

The estimated time to perform this alternative is also based on equipment production rates load and haul times and the estimated trip durations to the onsite landfill Time to complete backfill operations will depend on the length of the haul routes from the offsite clean borrow sources and the time required for the trucks to pass RFETS security It is estimated that a maximum of one haul truck per 15 minutes should be expected

II 2 4 3 Disposal

Onsite disposal options do not currently exist at the RFETS but an onsite waste management facility is being designed and constructed The sitewide waste management facility will be constructed by second quarter



Note
All contaminated surface soils are removed and the area is backfilled with clean soils

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Figure II 2-3

Operable Unit No 2
Interim Measure/Interim Remedial Action
Alternative 4
Excavation and Disposal

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FY98 The 903 Pad and Windblown Soils Area is expected to meet waste acceptance criteria for the onsite waste management facility

II 2 4 4 Sampling and Analysis

A sampling and analysis plan would be prepared detailing activities that would be conducted to demonstrate clean closure and to verify that hazardous chemicals do not exist in soils A mobile laboratory equipped with analytical chemistry and alpha counters to measure plutonium and americium could reduce project analytical costs and expedite turnaround times The analytical chemistry portion of the mobile laboratory would be used to verify that soils do not contain hazardous chemicals The mobile laboratory would be removed from the site following completion of the remediation The utility of having a mobile laboratory will be assessed during remedial design No long term radiological monitoring of the remediated site should be necessary with this alternative

A radiological survey program would be performed before excavation operations to determine the exact areas requiring excavation After excavation activities were complete confirmation samples would be taken to confirm that no contamination in excess of the remediation goals existed and that the site could be clean closed

II 2 4 5 Site Restoration

Site restoration would be performed with the placement of clean backfill in the excavated portion of the 903 Pad and Windblown Soils Area. Backfill should consist of clean soils that can be easily placed and are capable of supporting vegetative growth If site restoration activities begin before the complete excavation of contaminated soils the placement of clean backfill must be sequenced with excavation activities Clean backfill should be imported to the site and stored in an independent laydown area before the start of backfill operations and with enough material stockpiled to keep the earthmoving equipment busy

II 2 5 ALTERNATIVE 5 EX SITU TREATMENT VIA STABILIZATION WITH RETURN TO EXCAVATION

This alternative consists of site preparation excavation of contaminated surface soils ex situ treatment using solidification or stabilization technology site restoration including backfilling the excavation using the treated soils and revegetation of the disturbed areas Radiological monitoring would be performed to ensure that radioactive materials are immobilized in the environment It is expected that this alternative could be implemented within approximately 1 year not including the time needed for treatability studies Figure II 2 4 presents the conceptual diagram for this remedial alternative The following subsections describe the process options of Alternative 5

II 2 5 1 Site Preparation

Site preparation activities for this alternative will be as described for Alternative 4

II 2 5 2 Excavation

Excavation of the contaminated surface s and confirmation sampling and analysis of the excavation will be as described for Alternative 4 (Section II 2 4)

II 2 5 3 Ex Situ Solidification and Stabilization

Initially contaminated soils could be excavated and transported by truck to an onsite treatment facility At the treatment facility soils would be fed into a mixer and combined with stabilization reagents Depending on the system used one or more dry or liquid reagents would be added to the waste in the mixer Actual mixing time would depend on the process the batch size and the types of reagents used Afterward the soil/binder mixture would be discharged or removed to an intermediate curing area or directly to a shipment staging area

The treatment facility would be located to minimize the distance from the active excavation A transportable system could be relocated as the remediation proceeded to various areas of the OU Typical processing rates for a single mobile system can be as high as approximately 40 cubic yards per day based on two operating shifts per day Using this rate it would take one mobile processing system approximately 1 year to process the 12 000 cubic yards from beneath the 903 Pad and the 3 1 acre contaminated area on the hillside

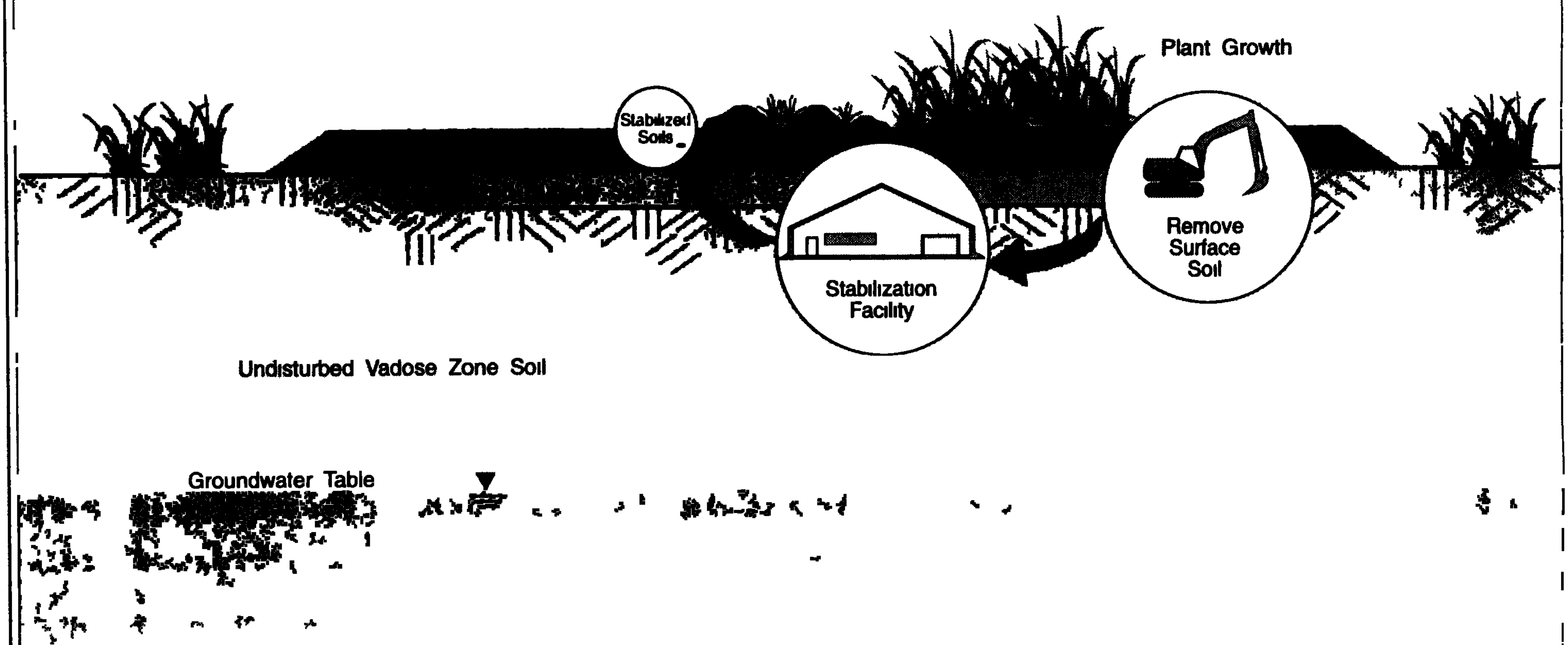
Process reagents would be provided in mobile bulk trailers and smaller bulk containers depending on the required quantities Use of bulk trailers and containers would minimize the area required for processing Required utilities typically would include electrical power at 480 volts AC and 100 amperes and intermittently process water at 10 gallons per minute Approximately 35 gallons of water per cubic yard of soil would be required depending on the binder formulation

II 2 5 4 Site Restoration

Site restoration would involve the placement of the stabilized soils and imported backfill in the excavated portion of the 903 Pad and Windblown Soils Area After backfilling the stabilized soil a shallow soil cover would be placed and seeded to establish an erosion resistant surface cover The backfill will consist of approximately 2 5 feet of clean soils that are placed contoured and seeded to support vegetative growth

II 2 5 5 Institutional Actions

Deed restrictions and access restrictions for this alternative would be similar to those implemented for Alternative 2 as described in Section II 2 2 Radiological monitoring for both airborne particulates ambient gamma field monitoring and surface water runoff would also be conducted as described in Section II 2 2



Note
All contaminated surface soils are removed for *ex situ* stabilization and returned to the excavation

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Figure II.2-4
Operable Unit No 2
Interim Measure/Interim Remedial Action
Alternative 5
***Ex Situ* Treatment via Stabilization With Return to Excavation**

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II 3 DETAILED ANALYSIS EVALUATION CRITERIA

A detailed evaluation was conducted to select the preferred IM/IRA The provisions contained in Section IX C of the IAG were followed to perform the detailed analysis because the IM/IRA will be consistent with the final remedy for the surface soils in OU 2 The IAG selection criteria are consistent with the statutory mandates of CERCLA Section 121 and the nine evaluation criteria presented in the NCP An explanation of the evaluation criteria used for the selection of the preferred IM/IRA is provided below

The performance objectives in Section IX C of the IAG require the IM/IRA to

- Protect human health and the environment
- Comply with ARARs unless a waiver is justified
- Be cost effective
- Utilize permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable
- Address the preference for treatment as a principal element

In assessing the remediation alternatives the following items were considered

- Long term uncertainties associated with land disposal
- Goals objectives and requirements of the Solid Waste Disposal Act
- Persistence toxicity mobility and propensity to bioaccumulate the hazardous substances and their constituents
- Short and long term potential for adverse health effects from human exposure
- Long term maintenance costs
- Potential for future remedial action costs if the alternative should fail
- Potential threat to human health and the environment associated with excavation transportation and redisposal or containment

The nine evaluation criteria used to compare the various alternatives with respect to the above mentioned performance objectives are listed in Figure II 3 1 Descriptions for each evaluation criterion are provided below

THRESHOLD CRITERIA	• Overall Protection of Human Health and the Environment • Compliance with ARARs
PRIMARY BALANCING CRITERIA	• Long Term Effectiveness and Permanence • Reduction of Toxicity, Mobility, or Volume through Treatment • Short Term Effectiveness • Implementability • Cost
MODIFYING CRITERIA	• Regulatory Agency Acceptance • Community Acceptance

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Figure II 3-1

Operable Unit No. 2
Interim Measure/Interim Remedial Action
Evaluation Criteria

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<u>Threshold Criteria</u>

The following two threshold criteria are mandatory requirements that must be satisfied for an alternative to be selected

(1) **<u>Overall protection of human health and the environment</u>** is the ability of an alternative to adequately eliminate reduce or control the chemical and radiological risks associated with each exposure pathway The alternatives were assessed to determine both long and short term risks to human health and the environment In this way ALARA characteristics of each alternative could be compared The radionuclide concentrations for a 15 mrem annual exposure were established as the remediation goals for protecting human health Compliance with this evaluation criterion is based on an alternative s ability to isolate the contaminated media in excess of the allowable concentrations so that human health and environmental exposures are eliminated

(2) **<u>Compliance with ARARs</u>** is the ability of an alternative to satisfy the requirements specified in the ARARs The alternatives were assessed to determine if the identified ARARs will be satisfied or provide grounds for invoking a waiver Table II 3 1 lists the potential location and action specific ARARs and TBCs for each alternative

<u>Primary Balancing Criteria</u>

Primary balancing criteria are used to identify and compare the major tradeoffs among the alternatives The balancing criteria allow the alternatives to be ranked and to determine the preferred IM/IRA Balancing criteria include the following

(1) **<u>Long term effectiveness and permanence</u>** is the anticipated ability of an alternative to maintain reliable protection of human health and the environment over time once the IM/IRA objectives are met Alternatives were assessed to determine the long term effectiveness and permanence they afford along with the degree of certainty that the alternative will prove successful Factors that may be considered in this assessment include the magnitude of residual risk remaining from untreated waste or from treatment residuals of the remedial activities The adequacy and reliability of controls necessary to manage treatment residuals and untreated waste such as containment systems and institutional controls were also considered

Table II 3 1
Potential Location and Action Specific ARARs and TBCs for Source Areas for Surface Soil Contamination

ARAR and TBC Citation	Requirement Description	Alternative: NFA[a]	Institutional Controls	Cap in Place	Excavate Onsite Disposal	Excavate Ex Situ Solidification/Stabilization Return
16 USC §§ 469 and 470 36 CFR 296 and 800 43 CFR 3 and 7 CRS 24-80-401 to 410	Historic and archeological preservation[b]	ARAR	ARAR	ARAR	ARAR	ARAR
16 USC § 661 *et seq*	Fish and Wildlife Coordination Act	ARAR	ARAR	ARAR	ARAR	ARAR
16 USC § 668	Eagle Protection Act	ARAR	ARAR	ARAR	ARAR	ARAR
16 USC § 701 715 50 CFR 10	Migratory Bird Treaty	ARAR	ARAR	ARAR	ARAR	ARAR
16 USC § 1531 50 CFR 402 and 424 CRS 33 2 101 to 33 2 107	Evaluate federal projects for potential impact to endangered or threatened species or critical habitats	ARAR	ARAR	ARAR	ARAR	ARAR
50 CFR 17	Endangered and threatened wildlife and plants	ARAR	ARAR	ARAR	ARAR	ARAR
33 USC § 1344 10 CFR 1022 33 CFR 323	Evaluate federal projects for potential floodplain and wetland impacts[c]	ARAR	ARAR	ARAR	ARAR	ARAR
10 CFR 834 (Proposed)	DOE radiation protection requirements for public health and the environment[d]	TBC	TBC	TBC	TBC	TBC
DOE Order 5820 2A Chapter III	Low level radioactive waste management			TBC	TBC	TBC
40 CFR 61 Subpart H/ 10 CFR 834 (Proposed)	NESHAP radionuclide emissions		ARAR/TBC	ARAR/ TBC	ARAR/TBC	ARAR/TBC
5 CCR 1001 Regulation 1	Fugitive particulate emissions[e]	—	ARAR	ARAR	ARAR	ARAR
40 CFR 122 26 5 CCR 1002 3 122 26	NPDES storm water management requirements	—	—	ARAR	ARAR	ARAR
40 CFR 262 11 6 CCR 1007 3 262 11	Hazardous Waste Determinations	—	—	—	ARAR	ARAR

a NFA No further action
b Although no historic or archeological sites are expected to be impacted all federal actions are required to be assessed
c Although no wetlands are expected to be impacted all federal actions are required to be assessed
d This regulation is proposed by the DOE to control radiation exposure for the protection of public health and the environment Although the Nuclear Regulatory Commission (NRC) also has similar protection standards promulgated under 10 CFR 20 1301 the DOE regulation is identified as an ARAR for compliance purposes since the DOE regulation is consistent with the NRC standards and will be applicable to RFETS when promulgated
e This standard would involve the control of fugitive particulates during regrading and/or excavation activities

(2) **Reduction of toxicity, mobility, or volume through treatment** is the anticipated performance of any treatment technologies Alternatives which employ treatment were assessed for their ability to reduce toxicity mobility or volume of waste or residuals

(3) **Short term effectiveness** is the time required to achieve the IM/IRA objectives and assess the adverse human health and environmental impacts resulting from implementation of the alternative The alternatives were assessed to determine their short term effectiveness by considering the following

Short term risks that might be posed to the community during implementation of the alternative (i e ALARA concerns)
Potential impacts on workers during implementation of the alternative
The effectiveness and reliability of protective measures
Potential environmental impacts of the alternative
The effectiveness and reliability of mitigative measures during implementation
The time required to achieve protection

(4) **Implementability** is the technical and administrative feasibility and availability of materials and services required to implement an alternative The alternatives were assessed to determine the ease or difficulty of their implementation by considering the following factors

Technical feasibility including technical difficulties and unknowns associated with the construction and operation of a technology
Reliability of the technology
Ease of undertaking additional remedial actions (if required)
Ability to monitor the effectiveness of the remedy

(5) **Cost** is the amount of funds required to implement an alternative The alternatives were assessed to determine capital costs including both direct and indirect costs The operating costs associated with treatment would likely be realized over a period of less than 1 year Therefore these operating costs were included as capital costs Longer term O&M costs were evaluated with a present worth analysis over a 30 year period The annual inflation rate was assumed to be 3 5 percent

Modifying Criteria

Modifying criteria reflect the concerns of the regulators and the community These criteria will not be entirely known until the public comment period is over These criteria will be considered along with any new information when preparing the responsiveness summary and may result in the modification of the preferred IM/IRA Modifying criteria include the following

(1) **Regulatory agency acceptance** is the ability of the preferred IM/IRA to address all of the concerns raised by the regulatory agencies These include the agencies positions and key concerns related to the preferred IM/IRA and other alternatives and agency comments on compliance with the ARARs or the proposed use of waivers These concerns are discussed in this IM/IRA decision document and will be considered during preparation of the responsiveness summary

(2) **Community acceptance** refers to the public s general response to the preferred IM/IRA described in this IM/IRA decision document including community support or opposition to the preferred IM/IRA alternative These concerns will be considered when preparing the responsiveness summary

II 4 DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis of alternatives considered the relevant information and resulted in the selection of a remedial alternative for the 903 Pad and Windblown Soils IM/IRA Individual alternatives were assessed against the evaluation criteria presented in Section II 3 A comparative analysis among the alternatives to assess the relative performance of each alternative with respect to each evaluation criterion was also performed

II 4 1 INDIVIDUAL ANALYSIS OF ALTERNATIVES

The following section presents an individual assessment and summary profile of each alternative against the evaluation criteria presented in Section II 3 Each alternative was evaluated against the threshold criteria which address overall protection of human health and the environment and compliance with ARARs Alternatives that did not meet the threshold criteria were eliminated from further consideration Alternatives which met the threshold criteria were then rated using the primary balancing criteria. The alternative was given a rating of low medium or high for the threshold criteria. High signifies the alternative meets all of the factors related to the criteria while low signifies that the alternative only minimally meets the criter a

II 4 1 1 No Further Action Alternative

Overall Protection of Human Health and the Environment

The no further action alternative would not adequately protect human health and the environment This alternative would not be protective of human health and the environment because radioactive contaminants present in surface soil would not be reduced to meet remediation goals for any of the exposure pathways The alternative was retained for comparison purposes only to allow the other alternatives to be ranked against a baseline

Compliance with ARARs and TBCs

Although the no further action alternative is expected to comply with the location specific and action specific ARARs and TBCs listed in Table II 3 1 this alternative will not comply with chemical specific TBC criteria identified for Pu 239/240 and Am 241 Even though the no further action alternative does not meet the threshold criteria the primary balancing criteria were evaluated to provide a baseline comparison in accordance with EPA guidance (EPA 1988)

Long Term Effectiveness and Permanence

The no further action alternative will not meet remediation goals It will allow the potential migration of contaminants via surface water runoff biota, and wind erosion This alternative received a rating of low because it is not effective in decreasing the radiation dose associated with the site and is not considered a permanent solution

Reduction of Toxicity Mobility or Volume through Treatment

The no further action alternative does not include any treatment processes to reduce the toxicity mobility or volume of contaminated material Contaminants will not be immobilized and can continue to migrate via wind dispersion biota transport surface water runoff and other exposure routes The no further action alternative is ranked as low because no treatment is provided to reduce the toxicity mobility or volume of contamination

Short Term Effectiveness

The risks to onsite workers and the community surrounding the RFETS will not change from current conditions with the implementation of the no further action alternative No new or additional adverse environmental impacts are expected However continued uncontrolled contaminants in the surface soil may impact wildlife and surface water in the OU 2 area No mitigation measures or special controls will be implemented and no direct or indirect effects will be caused by the implementation of the no further action alternative This will not impact natural historical and/or cultural resources For this criterion the no further action alternative receives a high rating because there is no significant impact to construction workers and the public from the implementation of this alternative

Implementability

The no further action alternative is easy to implement and receives a high ranking for this criterion A sitewide radioactive air monitoring program which would be needed for this alternative already exists Additional ambient gamma field monitoring and surface water runoff sampling will be required The no further action alternative will not impact any future remedial actions of subsurface soil and/or groundwater in the OU 2 area

Costs

Table II 4 1 provides a summary of the rough order of magnitude (ROM) cost estimate developed for each of the alternatives evaluated in the DAA Back up information for the cost estimate is provided in Appendix C For the no action alternative there are no capital costs The annual O&M costs for sampling and analysis and site inspections are estimated to be $153 260 The present worth of this alternative is estimated to be $3 391 032 These costs are based on a 30 year O&M period

II 4 1 2 Institutional Controls Alternative

Overall Protection of Human Health and the Environment

The institutional controls alternative is not protective of human health and the environment because the three exposure pathways would not be eliminated and remediation goals would not be met Although the alternative may reduce the potential for humans to come in contact with the contaminants the alternative would not reduce the radiation dose posed to human health and the environment or eliminate the following contaminant transport mechanisms wind dispersion surface water runoff or biotic transport.

Table II 4 1
OU 2 IM/IRA Draft Cost Estimates for Remedial Alternatives

	No Further Action	Enhanced Vegetative Cover	Excavation and Onsite Disposal	Excavation and Ex Situ Stabilization
Capital Costs	$0	$3 253 008	$9 369 378	$4 736 449
Annual O&M	$153 260	$179 948	$0	$170 307
Present Worth O&M	$3 391 032	$3 947 909	$0	$3 770 592
Present Worth Total	$3 391 032	$7 200 917	$9 369 378	$8 507 041

Based on 22 000 cubic yards Actual volumes are probably lower

Compliance with ARARs and TBCs

The institutional controls alternative is expected to comply with location specific and action specific ARARs listed in Table II 3 1 but will not comply with chemical specific TBC criteria identified for Pu 239/240 and Am 241 Existing residual soil concentrations for these radionuclides would remain onsite above remediation goals The institutional controls alternative will not be further evaluated because it does not meet the threshold criteria

II 4 1 3 Enhanced Vegetative Cover Alternative

Overall Protection of Human Health and the Environment

The enhanced vegetative cover alternative would reduce exposure to contaminated surface soil so that remediation goals are met The alternative would be effective in both the short and long term for protection of human health and the environment

Compliance with ARARs and TBCs

The enhanced vegetative cover alternative will comply with chemical specific location specific and action specific ARARs and TBC criteria listed in Table II 3 1 No waivers and variances are anticipated

Long Term Effectiveness and Permanence

The enhanced vegetative cover alternative will meet performance objectives of the IM/IRA by containing the contaminated surface soils and blocking the potential contaminant transport mechanisms of biotic transport surface water runoff and wind dispersion The geotextile gravel and riprap layers would act as a biotic barrier to keep burrowing animals and roots from penetrating into the contaminated soils and prevent worms from migrating from the contaminated zone into the vegetative cover materials Research results from the Los Alamos National Laboratory indicate that vegetative covers in semiarid environments can be very effective at reducing infiltration of precipitation This would reduce the potential migration of contaminants to the groundwater and reduce the potential for groundwater contamination Snow melt is the primary concern in the RFETS region and could reduce the effectiveness of this alternative during a short period each year However the expected frequency in conjunction with adequate design would not be expected to have a significant impact on groundwater recharge or quality

This alternative is considered a permanent solution because the contaminated soils will remain onsite in a controlled environment Land use restrictions will need to be incorporated into the RFETS wide land use plan All long term management monitoring and O&M as discussed in Section II 2 3 will be performed with few difficulties and uncertainties because conventional postclosure care equipment and personnel are readily available Cover failure due to catastrophic events such as an earthquake or flood is unlikely The enhanced vegetative cover alternative is rated as medium for this criterion because it is effective in meeting performance specifications but still requires O&M

Reduction of Toxicity Mobility or Volume through Treatment

The enhanced vegetative cover alternative will reduce the mobility of the contaminants from wind dispersion surface water runoff and direct human contact The cover will also reduce the potential for contamination migration via biota such as plants burrowing animals and earthworms By limiting the infiltration of surface water the cover will reduce the potential for contamination to migrate to the subsurface soils and groundwater

Since the surface soils will not be treated there will be no reduction in the toxicity or volume of contaminated materials Therefore this alternative is rated as medium The mobility of the contaminants is reduced but no treatment of contaminants is provided to reduce the toxicity or volume of contamination

Short Term Effectiveness

Radiation dose to the community from grading and construction of the enhanced vegetative cover will be minimal Risks to onsite workers are expected to be minimal and can effectively be controlled through mitigative measures such as dust controls use of personal protective equipment limiting worker exposure durations adhering to OSHA standards locating and deactivating underground and aboveground utilities before excavation and preparing and abiding bv a health and safety plan Administrative and engineering controls will mitigate release of radioactive airborne particulates during construction Air monitoring will be performed during construction activities to confirm that the mitigation measures are effective A contingencv plan will be prepared for managing unexpected conditions

The physical disruptions due to construction will temporarily limit the use of the 903 Pad and Windblown Soils Area Vegetation wildlife and surface water may be temporarily disrupted due to traffic changing drainage patterns and soil erosion with the implementation of this alternative Traffic controls erosion control measures and restoration of the remediated area should limit environmental impacts Special controls for the protection of wetlands flood plains critical habitats and endangered species will not be required

Soil and materials used to construct the enhanced vegetative cover will be irreversibly and irretrievably committed The indirect impacts from the construction of the vegetative cover will include a small short term increase in traffic positive impact to the plants and animals living around the area and a minimal impact to local hydrogeology The enhanced vegetative cover alternative is rated medium because small temporary impacts to traffic the site and onsite workers will be experienced from the construction of the cover

Implementability

The vegetative cover can be readily implemented based on the sloping grade of the site No specific site conditions should reduce the implementability of this alternative Only conventional construction methods and procedures are anticipated Borrow sources for the soil required to construct the cover should be readily available onsite or locally offsite No unique design attributes materials equipment or construction techniques would be required This alternative requires equipment and labor skills that are available in the Denver area It should be acceptable to the regulators because it is effective implementable and has been proven at other sites in semiarid environments

The enhanced vegetative cover alternative could be implemented in an expedited manner No treatability testing or site specific design studies will be required to implement the vegetative cover

Construction of an enhanced vegetative cover limits access to subsurface soils and groundwater in the area that is covered Future remedial activities of subsurface soil and/or groundwater may be adversely affected by the presence of a vegetative cover in the 903 Pad and Windblown Soils Area The enhanced vegetative cover alternative receives a high ranking for implementability The cover can be constructed with readily available equipment and materials with no need for treatability testing

Costs

The estimated capital cost of the vegetative cover is approximately $3 253 008 for the 4 0 acre cover area The O&M costs would be moderate due to periodic inspections and potential repairs of any erosional damage Long term air radiological and surface water monitoring would be required Annual O&M costs are estimated to be $179 948 and the total present worth of this alternative is estimated to be $7 200 917 A summary of the cost estimate is provided in Table II 4 1 Appendix C provides the cost estimate details

II 4 1 4 Excavation and Disposal Alternative

Overall Protection of Human Health and the Environment

Excavation and onsite disposal of contaminated surface soil would reduce surface soil concentrations of Pu 239/240 and Am 241 to meet remediation goals The soil would be excavated and disposed of to maximize short and long term effectiveness and to reduce risks to human health and the environment

Compliance With ARARs

The excavation and disposal alternative will comply with chemical specific location specific and action specific ARARs and TBC criteria No waivers and variances are anticipated

Long Term Effectiveness and Permanence

The excavation and disposal alternative will meet remediation goals Contaminated soil would be removed from the 903 Pad and Windblown Soils Area. Thus the exposure pathways would be eliminated Long term management monitoring and O&M would not be required The excavation and disposal alternative is rated as high because the contaminated soil would be removed from the site

Reduction of Toxicity Mobility or Volume through Treatment

The excavation and disposal alternative does not utilize treatment to reduce the toxicity mobility or volume of contaminated soil The contaminated medium is removed from the 903 Pad and Windblown Soils Area thus eliminating the risks at this area The risks associated with the contaminated soils are transported to another location where the ultimate reduction of mobility will depend on the effectiveness of the disposal facility The alternative also will involve volume reduction through field sampling and soil segregation This alternative is ranked as medium because no treatment of contaminants is provided to reduce the toxicity however reduced mobility of contaminants and volume of contaminated soils is expected

Short Term Effectiveness

The short term risk to the community from the excavation and disposal alternative would be minimal Applicable controls mitigation measures construction worker risk special controls and temporary disruptions are similar to those discussed for the enhanced vegetative cover short term effectiveness

Materials that are irreversibly and irretrievably committed for this alternative will include fuels consumed during the collection and hauling of the contaminated soils plus the space in the onsite landfill and the soils and materials used to construct the landfill The indirect impact from the excavation and disposal alternative includes positive impacts to the plants and animals living around the 903 Pad and Windblown Soils Area in the short term Plant and animal impacts in the area will be minimal in the long run because of rehabitation of the area Also a minimal impact to local surface water hydrology is expected No land use restrictions will be required The excavation and disposal alternative is rated as medium because there will be a small short term impact to traffic the site onsite workers and the risks due to the transportation of contaminated materials

Implementability

Future remedial actions of subsurface soil and/or groundwater in the OU 2 area will not be impacted by the implementation of the excavation and disposal alternative While issues may exist with respect to obtaining the necessary approvals and permits they are not believed to be insurmountable The low level radioactive contaminated material could be stored in containers until the onsite disposal facility is ready or could be left in place Required equipment and skilled workers for construction and operation of this alternative should be available No constructability issues due to site conditions are anticipated

Adequate onsite disposal capacity does not currently exist at RFETS However a sitewide waste management facility is currently being designed and permitted This facility is scheduled to be ready to receive remediation wastes in second quarter FY98 Onsite disposal is preferred over offsite disposal (RMRS 1994) Implementability is contingent upon regulatory approval for the onsite disposal facility The 903 Pad and Wind Blown Soils program would be expected to demonstrate that the contaminated surface soils are in compliance with the waste acceptance criteria for the sitewide waste management facility The excavation and disposal alternative is ranked high for implementability because it will be easy to implement (if the sitewide waste management facility is permitted and constructed)

Costs

Table II 4 1 provides a summary of the cost estimate for each alternative and Appendix C provides back up information for the cost estimate Capital costs for the excavation and disposal alternative include costs associated with excavation sampling transportation onsite disposal and regrading with clean backfill Costs for container storage of surface soils is not included The capital costs are estimated to be $9 369 378 The excavation and disposal alternative would not incur any annual O&M costs and therefore the total present worth of this alternative is $9 369 378

II 4 1 5 Ex Situ Treatment via Stabilization with Return to Excavation Alternative

Overall Protection of Human Health and the Environment

This alternative was determined to be protective of human health and the environment because remidiation goals would be met in surface soil The alternative is effective in reducing short and long term risks to human health and the environment

Compliance with ARARs

The ex situ treatment via stabilization with return to excavation alternative is expected to comply with chemical specific location specific and action specific ARARs and TBC criteria No waivers or variances are anticipated

Long Term Effectiveness and Permanence

This alternative will meet IM/IRA remediation goals by reducing the potential for contaminant migration and reducing exposure pathways Confirmation samples will be taken during the entire processing period to ensure that all stabilized materials meet quality assurance standards The long term use of the 903 Pad and Windblown Soils Area will not need to be restricted

Stabilization has been proven to be effective at immobilizing metal contaminants in soils at full scale Radioactive metal and metal oxide contaminants that occur in commercial nuclear power plant liquid and solid wastes have been successfully solidified and/or stabilized in the United States for shallow land disposal during the past three decades using cementitious binders and more recently with bituminous binders Bitumen has been commonly used for a longer time in Europe and Asia for these types of wastes Cementitious and pozzolanic binders have been successfully used during the past decade for the solidification and stabilization of metal and organic contaminated hazardous wastes including soils

The commercially available stabilization processing equipment is considered reliable O&M of the processing equipment will be required during treatment for this alternative The ex situ treatment via stabilization and return to excavation alternative is rated as high because it is an effective and permanent solution

Reduction of Toxicity Mobility or Volume through Treatment

Stabilization will immobilize the contaminants in the soil to reduce mobility However stabilization will significantly increase the volume of contaminated material The rating for this alternative is medium because ex situ stabilization will reduce the mobility of the contaminated soils but it will increase the volume of contaminated material

Short Term Effectiveness

The risk to the community from the ex situ treatment via stabilization and return to excavation alternative is minimal Applicable controls mitigation measures special controls and temporary disruptions are consistent with those discussed for the enhanced vegetative cover short term effectiveness Dust controls will be provided to minimize fugitive air emissions to ensure protection of the community Ex situ treatment of the contaminated surface soil will pose physical and chemical risks to onsite workers because exposure from process chemicals and potentially dangerous equipment could result during the handling and processing of the soils

Clean backfill to cover the stabilized mass after treatment will be required to support vegetative growth These materials along with fuels and process chemicals will be irreversibly and irretrievably committed The indirect impacts from this alternative will create positive impacts to the plants and animals living around the 903 Pad and Windblown Soils Area and a minimal impact to local surface water hydrology The alternative is rated as medium for short term effectiveness because there will be temporary disturbances of the site and potential contaminant exposure to onsite workers

Implementability

Treatability testing will be required to determine the best chemical binders Additional considerations include the throughput rate of waste type of mixing equipment required optimum size of the chemical feed system matching the chemical feed system with the waste feed system and utility and power requirements for the stabilization unit Completion of these studies could impact the implementation of this remediation alternative

Treatment facility size can vary to suit the required processing rate If desired the equipment can be modularly arranged to facilitate mobilization between processing sites However generally as the facility size increases the transportability of the system diminishes and becomes more complicated

Typically ex situ stabilization facilities have been operated in batch mode to accommodate the handling requirements of waste packages destined for offsite disposal Customized ex situ treatment facilities have been designed to process certain DOE wastes continuously or in semibatch mode therefore considerations are needed in the process design for treatment of contaminated soils regarding (1) the requirements of the final waste form total processing time and processing rate (2) logistics of moving the contaminated soil to the treatment facility or moving the treatment facility to specific areas of contaminated soils and (3) potential future use of the facility for other RFETS projects

The previously mentioned considerations notwithstanding an ex situ stabilization facility can be designed and implemented to process contaminated soils that would comply with all project requirements Multiple systems would be anticipated since the throughput of a single system of this nature is about 2 cubic meters per hour Use of multiple small systems has the advantages of ease of transportation and processing rate versatility The components of this system could be moved to various locations using a flatbed and/or fork truck A modular system (or systems) with higher throughput could be designed and purchased or leased to treat contaminated soils This type of system would be moved by flatbed and/or crane and would involve more time to set up and tear down between operational sites than the smaller systems A fixed plant may also be considered but will involve semipermanent or permanent allocation of real estate

Reagents for use by a stabilization plant could be supplied through bulk trailers or containers Containers for the stabilized product if used will require a storage area near the processing site Analytical laboratory services will be required for product quality control and could be contracted or provided by existing RFETS facilities

The placement of stabilized wastes on the surface of the 903 Pad and Windblown Soil Area may restrict future remedial actions of subsurface soil and/or groundwa n this area. The waste will need to demonstrate compliance to the waste acceptance criteria This alternative is rated as medium for implementability because treatability testing and a longer implementation schedule are required

Costs

Capital costs for this alternative include excavation stabilization transportation backfill and grading The total capital costs are estimated to be $4 736 449 as shown in Table II 4 1 Annual maintenance costs which include site inspections and sampling and analysis are estimated to be $170 307 Details of the cost estimate are provided in Appendix C The present worth of this alternative is estimated to be $8 507 041

II 4 2 CONCLUSIONS AND RECOMMENDATIONS

The analysis determined that both the no further action and institutional controls alternatives should be eliminated from further consideration in the comparative analysis of alternatives because they did not meet the threshold criteria. However the no further action alternative will be included in the comparative analysis as a baseline The remaining three alternatives are also considered in the comparative analysis enhanced vegetative cover excavation and disposal and ex situ treatment via stabilization with return to excavation

Each of the primary balancing criteria was analyzed and scored with respect to the subtopics listed on Table II 4 2 Each alternative was scored with a value of 1 through 5 for each subtopic A value of 5 was assigned if an alternative achieved all of the requirements of the sub topic and was considered to be the best alternative for the subtopic A value f ' was assigned to an alternative if it did not meet the requirements of the sub topic and was considered he Values of 2 3 and 4 indicated how well an alternative met the requirements of a subtopic in compar n to the other alternatives A score of 5 equates to the high rating presented in Section II 4 1 and a score of 1 represents a low rating A score of 2 3 or 4 equates to a medium rating dependent upon a comparison between alternatives The scores for each of the alternatives were then added to arrive at an overall score for each alternative The alternative with the highest score was considered to be the most appropriate alternative for the contaminated 903 Pad and Windblown Soils Area The following paragraphs provide the results of the comparative analysis for each of the primary balancing criteria. A summary of comparative analysis of alternatives is provided in Table II 4 3

II 4 2 1 Long Term Effectiveness and Permanence

The excavation and disposal alternative scored the highest with a value of 5 in all topics because the contaminants are removed from the site This results in complete blocking of the exposure pathways and elimination of residual risk The enhanced vegetative cover and ex situ stabilization alternatives each received a score of 4 with respect to the mitigation of exposure pathways because both alternatives would block the exposure pathways Ex situ stabilization received a score of 4 for the magnitude of residual risk because the remaining contaminants are being treated and their potential mobility are being reduced The enhanced vegetative cover alternative received a score of 3 for this subtopic because the contaminants remaining inplace are not treated It was determined that all of the remedial alternatives were equal to a value of 5 with respect to adequacy and reliability of monitoring and controls The excavation and disposal alternative is considered to be a permanent solution with a value of 5 whereas under the enhanced vegetative cover and ex situ stabilization alternatives the contaminants would remain in place where they could under failure conditions provide a source of future contamination with a value of 4

The no further action alternative received the lowest score with a value of 1 for the mitigation of exposure pathways magnitude of residual risk, and permanence because contaminants would be left in place untreated and uncontrolled Based on the analysis of this criterion the alternatives were ranked from the highest to lowest excavation and disposal ex situ stabilization enhanced vegetative cover and no further action

II 4 2 2 Reduction of Toxicity Mobility or Volume through Treatment

The no further action enhanced vegetative cover and excavation and disposal alternatives all scored the lowest value of 1 because none of these alternatives destroy or treat any of the contaminants contained in the soils The ex situ treatment alternative scored a value of 4 because while it addresses mobility contaminants were only treated but not destroyed

The enhanced vegetative cover excavation and disposal and ex situ stabilization alternatives all scored a value of 3 with respect to the expected reduction of toxicity mobility and volume The enhanced vegetative cover and ex situ stabilization alternatives will reduce mobility while the excavation and disposal alternative will reduce the volume of contamination

The no further action alternative scored a value of 1 for both subtopics because this alternative provides no reduction in toxicity mobility or volume Based on the analysis of this criterion the alternatives were ranked from the highest to lowest ex situ stabilization excavation and disposal and enhanced vegetative cover were equal and no further action

II 4 2 3 Short Term Effectiveness

With respect to the protection of the public during construction the no further action alternative scored the highest with a value of 5 because no construction activities would be performed The enhanced vegetative cover scored a value of 4 because the least amount of contaminants would be excavated and exposed The excavation and disposal and ex situ stabilization alternatives both received scores with a value of 3 because under these alternatives the largest volume of contaminated soil would be excavated and exposed for potential airborne migration to public receptors

Table II 4 2
Detailed Summary of Comparative Analysis of Alternatives

Evaluation Criteria	Remedial Alternative			
	No Further Action	Enhanced Vegetative Cover	Excavation and Disposal	Ex Situ Treatment with Stabilization Return to Excavation
Overall Protection of Human Health and the Environment	No	Yes	Yes	Yes
Compliance with ARARs	No	Yes	Yes	Yes
Long Term Effectiveness and Permanence				
Mitigation of exposure pathways	1	4	5	4
Magnitude of residual risk	1	3	5	4
Adequacy and reliability of controls	5	5	5	5
Permanence	1	4	5	4
Reduction of Toxicity, Mobility, or Volume through Treatment				
Amount of contaminant destroyed or treated	1	1	1	4
Expected reduction in toxicity mobility and volume	1	3	3	3
Short Term Effectiveness				
Protection of public during construction	5	4	3	3
Protection of onsite workers during construction	5	4	3	2
Time until remedial actions are complete	1	5	5	5
Environmental impacts	5	4	3	2
Implementability				
Technical feasibility of operation and construction	5	5	5	4
Reliability of technology	5	4	5	3
Availability of services and material	5	5	5	4
Effect on future site remedial actions	4	2	5	3
Cost				
Capital cost	5	3	1	3
Annual operation and maintenance	3	3	5	3
Regulatory Acceptance	TBD	TBD	TBD	TBD
Community Acceptance	TBD	TBD	TBD	TBD
Final Score	53	59	64	56

Note TBD To be determined upon receipt of comments from the Regulatory Agencies and the community

Table II 4 3
Summary of Comparative Analysis of Alternatives

	Remedial Alternative			
Evaluation Criteria	No Further Action	Enhanced Vegetative Cover	Excavation and Disposal	Ex Situ Treatment with Stabilization Return to Excavation
Overall Protection of Human Health and the Environment	No	Yes	Yes	Yes
Compliance with ARARs	No	Yes	Yes	Yes
Long Term Effectiveness and Permanence	2	4	5	4
Reduction of Toxicity Mobility or Volume through Treatment	1	2	2	4
Short Term Effectiveness	4	4	4	3
Implementability	5	4	5	4
Cost	4	3	3	3
Regulatory Acceptance	TBD	TBD	TBD	TBD
Community Acceptance	TBD	TBD	TBD	TBD
Final Score	16	17	19	18

Note TBD To be determined upon receipt of comments from the Regulatory Agencies and the community

With respect to the protection of workers during construction the no further action alternative scored the highest with a value of 5 because there would not be any construction activities The enhanced vegetative cover excavation and disposal and ex situ stabilization alternatives scored 4 3 and 2 respectively because of the amount of excavation and the amount of contact between workers and the contaminants The workers would have the most contact with contaminated materials under the ex situ stabilization alternative because of the excavation contact during processing and quality control testing of the treated product

The enhanced vegetation cover excavation and disposal and ex situ stabilization alternatives will all meet the remedial action objectives in about the same time (5) The no further action alternative scored low with a value of 1 because under this alternative the remedial action objectives will not be realized

With respect to the anticipated environmental impacts the no further action alternative scored the highest with a value of 5 because there will not be any construction activities The enhanced vegetative cover alternative scored a value of 4 because the anticipated construction related impacts would be minimal The excavation and removal alternative scored a value of 3 because an excavation would be open for a short period during construction The ex situ stabilization alternative scored a value of 2 because the excavation would be open for the longest period (during treatment) and the tr ent system may have slight environmental impacts Based on the analysis of this criterion the alternati were ranked as follows no further action enhanced vegetative cover excavation and disposal and ex situ stabilization

II 4 2 4 Implementability

With respect to both technical feasibility and availability of necessary services and materials the no further action enhanced vegetative cover and excavation and disposal alternatives all received a score of 5 All of these technologies are commonly used throughout industry and at DOE facilities The ex situ stabilization alternative received a score of 4 in these two subtopics because although this technology is used throughout industry and at DOE sites its effective operation is occasionally problematic and equipment is slightly more difficult to procure or fabricate

In regard to the technology reliability the no action and excavation and disposal alternatives score high with a value of 5 because these alternatives are proven effective The enhanced vegetative cover alternative scored slightly less with a value of 4 because engineered covers often have minor areas where failure occurs such as erosional problems or burrowing animals The ex situ stabilization alternative scored the lowest with a value of 3 because there have been stabilization projects that have not reached full potential (i e OU 4 pondcrete project) because of problems associated with quality control or scale up from a pilot scale to a full scale treatment system

No further action enhanced vegetative cover and excavation and disposal rated the highest with a value of 5 for availability of services and material This is because services and material are readily available for these remediation alternatives Ex situ stabilization is rated at a value of 4 for this because of a slight uncertainty in availability of services and materials

With respect to the effect of the OU 2 surface soil remediation on other future remedial actions the excavation and disposal alternative rated the highest with a value of 5 This alternative would not adversely affect future remediation of other media and would not require that a future remedial action address surface soils The no further action alternative had a slightly lower score with a value of 4 because future remedial actions would not be obstructed but remediation of surface soils may be necessary at that time The ex situ stabilization scored of 3 because the stabilized material could affect future remediation of subsurface soils or groundwater The enhanced vegetative cover alternative scored a value of 2 because it involves the largest volume of material that would need to be removed if it became necessary to gain access to the subsurface soils or groundwater for a future remedial action

Based upon the analysis of this criterion the alternatives were ranked from the highest to the lowest excavation and disposal no further action enhanced vegetative cover and ex situ stabilization were equal

II 4 2 5 Cost

With respect to capital cost the no further action alternative scores the highest with a value of 5 because no capital costs would be expended The enhanced vegetative cover alternative and the ex situ stabilization alternative received a score of 3 because their capital costs are more costly than the no further action alternative The excavation and disposal alternative scored a value of 1 because its capital costs are considerably more costly than the enhanced vegetative cover and the ex situ stabilization alternatives

For O&M costs the excavation and disposal alternative received the highest score with a value of 5 because this alternative would not require O&M expenditures The no further action enhanced vegetative cover and ex situ stabilization alternatives would require monitoring because contaminated materials would be left in place These alternatives would have similar monitoring requirements and similar costs All alternatives scored a value of 3 because the costs would be significantly higher than the O&M costs associated with excavation and disposal

Based upon the analysis of this criterion the alternatives were ranked from the highest to the lowest no further action enhanced vegetative cover excavation and disposal and ex situ stabilization were equal

II 4 2 6 Regulatory Agency Acceptance

Regulatory agency acceptance of the selected altern will not be known until after the public comment period

II 4 2 7 Community Acceptance

Communitv acceptance of the selected alternative will not be known until after the public comment period

II 4 3 SELECTION

Based on the results of the analysis of alternatives summarized in Table II 4 1 the DOE determined that the excavation and disposal of the contaminated surface soils in the onsite waste management facility should be the preferred IM/IRA alternative for the 903 Pad and Windblown Soils Area The excavation and disposal alternative is proposed for implementation because it will achieve or maximize the following IM/IRA objectives

Potential exposure to contaminated surface soils via direct contact, ingestion and inhalation will be eliminated due to the removal of the contamination source

The alternative will meet the identified ARARs and TBCs

Future remediation alternatives for subsurface soil or groundwater (if necessary) at OU 2 will not be adversely affected

The excavation and disposal alternative is consistent with the DOE goal of centrally locating contaminated media in a controlled and monitored sitewide waste management facility

Generation of new waste requiring treatment and disposal will be minimized

The spread of contaminants during construction will be minimized

The alternative is cost effective based on a present worth analvsis because long term monitoring and maintenance are not required

II 5 EXPLANATION OF SIGNIFICANT CHANGES

This section presents the functional and design requirements for the proposed alternative and discusses the strategy for implementation

II 5 1 DESIGN BASIS FUNCTIONAL REQUIREMENTS

The following functional objectives have been identified for the proposed excavation and disposal alternative

The surface soil remediation design shall assure that all surface soils above remediation goals are remediated

The gas detoxification building Building 952 within IHSS 183 shall be removed

The remedial design shall prevent the erosion of surface soil during extreme precipitation events

The surface soils shall be remediated to control minimize or eliminate to the extent necessary to protect human health and the environment the release of regulated waste constituents leachate or contaminated runoff to the surface water or the atmosphere

The excavation and disposal activities shall be conducted in a manner that minimizes exposure to environmental hazards

The excavation and disposal remedial action shall be designed to eliminate the migration of Pu 239/240 and Am 241 in surface soil via airborne particulates biotic transport and surface water and the need for long term management or maintenance

The closure/remediation design shall not impede any future remedial actions in the OU 2 area

The closure/remediation design shall maintain accurate records for contaminated soil including a manifest to document the proper classification and disposal of the material

The following design criteria have been identified for the proposed alternative

The excavation and disposal action will provide a storm water management system for dewatering and surface water control during construction

All excavated soil shall meet the waste acceptance criteria of the sitewide waste management facility

The excavated material shall be transported to the sidewide waste management facility in accordance with RFETS standards

The sitewide waste management facility is being designed under a separate project

Contaminated surface soils will be excavated until the concentration of contaminants in soils are below remediation goals

Excavations shall be backfilled with clean imported backfill and regraded to natural topographic contours to minimize the erosion of surface soil

The design for the remediation shall include specification of procedure to prevent the spread of contaminants to soil water or air during construction

The design shall include mitigation techniques to prevent airborne dust contamination during earthmoving and waste transfer Also drainage control stockpile coverage and other measures if required including collection and treatment of storm water to prevent surface water contamination shall be implemented The design shall include careful planning of stockpile management earth moving and waste transfer to prevent soil contamination

The design shall meet all applicable requirements as presented in Table II 5 1 for the following

1 Interagency Agreement (IAG) for the RFETS

2 Federal regulations

3 State of Colorado regulations

4 DOE Orders and Directives

5 RFETS standards and design criteria

II 5 2 IMPLEMENTATION PLAN

Several steps are required to implement the selected remedial alternative including the following

Develop a work plan for implementation of the selected remedial alternative

Perform radiological surveys in the areas to be excavated to identify areas exceeding remediation goals It is anticipated that this survey will use germanium detector technology These areas require removal

Excavate areas exceeding remediation goals

Perform radiological surveys and sampling to confirm that all contaminated soil was removed to below remediation goals

Complete excavation activities where required

Transport contaminated soil to proposed sitewide waste management facility

Backfill excavations with clean imported backfill

Regrade and seed affected areas

Implement erosion control measures

Develop report to document completion of excavation activities

Table II 5 1 presents the ARARs for the selected alternative specifying the implementation strategy

Table II 5 1
Implementation of ARARs for Selected Alternative

ARAR and TBC Category	Regulatory Requirement	Implementation/Compliance Strategy
Location Floodplain and Wetland Impacts	Federal agencies are to avoid construction within a floodplain or wetland unless there are no practical alternatives If it is necessary to locate any of the remediation facilities within a floodplain or wetland all practicable measures are to be taken to minimize any impacts to the floodplain or wetland Actions must minimize destruction loss or degradation of wetlands as defined by Executive Order 11990 Section 7 A floodplain or wetland assessment must be published in the Federal Register prior to taking any action within the floodplain/wetland to allow time for public review and comment 10 CFR 1022 (CRS 25 12 101 to 25 12 108) (Applicable) 33 CFR 323 (Applicable) 33 USC § 1344 (Applicable) Executive Orders 11988 & 11990 [To be considered]	A wetland assessment will be prepared prior to construction activities No floodplains have been identified in OU 2 The preferred IM/IRA construction activities will avoid any floodplain areas Therefore a floodplain assessment does not need to be prepared and special precautions do not need to be established
Location Historic and Archeological Preservation	The Secretary of the Interior must be notified in writing whenever DOE finds or is notified in writing by an appropriate historical or archaeological authority that the activities in connection with a project may cause irreparable loss or destruction of significant scientific prehistorical historical or archaeological data Any data that may be lost or destroyed must be preserved by the DOE or the Department of Interior 36 CFR 296 & 800 (CRS 20 80-401 to 410) [Applicable] 43 CFR 3 & 7 [Applicable] 16 USC §§ 469 and 470 [Applicable] DOE Environmental Compliance Guide (DOE/EP-0098) [To be considered]	Historic or archeological sites will not be impacted as a result of implementing the preferred IM/IRA Therefore notifications and provisions to preserve artifacts are not required
Location Endangered and Threatened Species Act	Practices shall not cause or contribute to the taking of any endangered or threatened species of plants fish or wildlife Taking is defined to include harassment harm pursuit hunting wounding trapping death capture or collection Threatened or endangered species indigenous to Colorado should be protected to maintain and enhance their numbers 50 CFR 402 & 424 (CRS 33 2 101 to 33 2 107) [Applicable] 16 USC § 1531 [Applicable] 50 CFR 17 [Applicable] 16 USC § 668 [Applicable] 50 CFR 10 [Applicable] 16 USC § 701 to 715 [Applicable] 16 USC § 661 [Applicable]	The American kestrel and the Preble s meadow jumping mouse have been identified in OU 2 If the 1995 habitat study indicates that the Preble s meadow jumping mouse forages or the American kestrel nests in areas of OU 2 that will be disturbed during remedial activities remediation plans for OU 2 may be terminated or rescheduled The bald eagle which is a threatened species has been spotted above RFETS Bald eagles have not been known to inhabit or nest in OU 2 If the 1995 habitat study indicates the bald eagle inhabits or nests in areas of OU 2 that will be disturbed during remedial activities the remediation plans for OU 2 may be terminated or rescheduled (See Appendix A Section 8 Ecology for more detail) If an endangered species is found then interagency cooperation is a TBC and the policy of DOE is that interagency cooperation will be complete

II 5 2 IMPLEMENTATION PLAN

Several steps are required to implement the selected remedial alternative including the following

Develop a work plan for implementation of the selected remedial alternative

Perform radiological surveys in the areas to be excavated to identify areas exceeding remediation goals It is anticipated that this survey will use germanium detector technology These areas require removal

Excavate areas exceeding remediation goals

Perform radiological surveys and sampling to confirm that all contaminated soil was removed to below remediation goals

Complete excavation activities where required

Transport contaminated soil to proposed sitewide waste management facility

Backfill excavations with clean imported backfill

Regrade and seed affected areas

Implement erosion control measures

Develop report to document completion of excavation activities

Table II 5 1 presents the ARARs for the selected alternative specifying the implementation strategy

Table II 5 1 (continued)

ARAR and TBC Category	Regulatory Requirement	Implementation/Compliance Strategy
Action General Public Health and the Environment	DOE activities are to be conducted so that radiation exposures to members of the public are maintained below acceptable limits This proposed regulation also addresses the management of real and personal property to control exposures to residual radioactive materials DOE facilities have the capability consistent with the types of operations conducted to monitor routine and nonroutine releases and assess doses 10 CFR 834 (Proposed) [To be considered]	Public exposure to radionuclides resulting from excavation activities will be calculated during the detailed design Dust suppression measurements (i e water sprays restriction of work during periods of high winds when fugitive particulate emissions are visible etc) will be employed as required to minimize radionuclide emissions Air monitoring will be performed during field activities to ensure that all activities comply with the DOE s plan for prevention of contaminant dispersion (PPCD).
Action General Waste Determination	A person who generates a solid waste must determine if that waste is a hazardous waste using the procedures identified in 40 CFR 262 11 An overview of the hazardous waste determination procedures is presented in 40 CFR 260 Appendix I 40 CFR 262.11 (6 CCR 1007 3, 262.11) [Applicable]	Any waste streams generated during the IM/IRA for disposal will be assessed for hazardous wastes by review of the OU 2 RFI/RI data base review of process/historical records and sampling and analysis (as required)
Action General Air Discharges	Any owner or operator of land that has been cleared of greater than one acre in non attainment areas from which fugitive emissions will be emitted shall be required to use all available and practical methods which are technologically feasible and economically reasonable to minimize such emissions in accordance with the requirements of 5 CCR 1001 Regulation 1 Section III D The RFETS is located in a non attainment area for particulates 5 CCR 1001 Regulation 1, III D [Applicable]	Dust suppression measurements (i e water sprays restriction of work during periods of high winds when fugitive particulate emissions are visible etc) will be employed as required to minimize fugitive particulate emissions Air monitoring will be performed during field activities to ensure that all activities comply with the PPCD
Action General Air Discharges (Radionuclides)	Emissions of radionuclides to the ambient air from DOE facilities shall not cause any member of the public to receive an effective dose equivalent in excess of 10 mrem per year above background This limit is based on an effective dose equivalent as calculated per the International Commission on Radiological Protection s Publication No 26 40 CFR 61 Subpart H [Applicable] 10 CFR 834 (Proposed) [To be considered] DOE Order 5400 5 [To be considered] DOE Order 5820 2A Chapter III [To be considered]	Public exposure to radionuclides resulting from potential fugitive emissions will be calculated during the detailed design Dust suppression measurements (i e water sprays restriction of work during periods of high winds when fugitive particulate emissions are visible etc) will be employed as required to minimize fugitive particulate emissions and ensure public exposure is less than 10 mrem/yr Air monitoring will be performed during field activities to ensure that all activities comply with the PPCD.
Action General Storm Water Management	Industrial facilities (as defined in 40 CFR 122 26) are required to submit an NPDES Stormwater Discharge Permit Application to US EPA by October 2 1992 This permit application is to identify the sitewide monitoring program (including monitoring parameters and locations) for all storm water discharges 40 CFR 122 26 (5 CCR 1002 3 122 26) [Applicable]	If required the sitewide NPDES permit will be modified prior to construction activities All monitoring will be done in accordance with the NPDES permit

II 5 3 SUBSURFACE SOIL INVESTIGATION

There is historical evidence that high concentrations of volatile organic compounds (VOC) may be present in the subsurface soils in the 903 Pad area, potentially in a Non Aqueous Phase Liquid (NAPL) form So that ground water is not continually degraded it is necessary to remediate any known VOCs sources above action levels underneath the 903 Pad Subsurface soil remediation activities at the 903 Pad will need to be closely coordinated with the surficial soil remediation activities Such coordination will be beneficial since the amount of time and money needed to remediate contaminated soils at the 903 Pad will be minimized In order to proceed with a subsurface soil remediation the data that supports the presence of VOCs in subsurface soils needs to be supplemented The following outlines the historical data along with a plan for proceeding with a subsurface soil remediation

Since drums of VOCs leaked into the soils at the 903 Pad area it is suspected that these VOCs could still be present in high concentrations in the subsurface soils This is confirmed by the results of the soil gas survey summarized in the <u>Final Operable Unit 2 Subsurface Interim Measures/Interim Remedial Action Plan/Environmental Assessment Soil Vapor Survey Report</u> (See Figure II 5 3 1) The soil gas survey identified areas in and around the 903 Pad where there are high concentrations of VOCs The relatively steep concentration gradients indicated by the soil vapor survey data suggests that NAPL is present in subsurface soils above the ground water table If NAPL was not present in subsurface soils or was only present underneath the ground water concentrations of volatile organic vapors would tend to be more uniform across the 903 Pad area

The concentrations of solvents identified in the ground water during the OU 2 RFI/RI investigation also suggest that NAPL is present in subsurface soils This is illustrated by the relatively high concentrations of tetrachloroethene seen under the 903 Pad (See Figure II 5 3 2) The solubility of tetrachloroethene is approximately 230 mg/liter The concentration of 14 mg/liter in the ground water underneath the 903 Pad is about 6% of the solubility limit Since concentrations of tetrachloroethene are above 1% of the solubility limit the presence of NAPL is suspected The 1% solubility limit is also exceeded for carbon tetrachloride in ground water Therefore the ground water monitoring results from the 903 Pad suggest the presence of NAPL

Due to the evidence presented above it is assumed that VOCs above action levels are present underneath the 903 Pad and should be remediated A focused investigation will be conducted to better delineate areas with high VOC concentrations The <u>Final Operable Unit 2 Subsurface Interim Measures/Interim Remedial Action</u>

Plan/Environmental Assessment Soil Vapor Survey Report dated June 1994 will be used as the basis for th- focused investigation

The results of the focused investigation will then be used to develop a Subsurface Soil Remediation Implementation Plan (SSRIP) The SSRIP will examine alternatives for remediating these sources in subsurface soils and a preferred alternative will be chosen The SSRIP will be reviewed and approved for use before remediation of surficial soils starts at the 903 Pad and will be implemented during the remediation

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TABLE OF CONTENTS

A 1 DEMOGRAPHY AND LAND USE

The population economics and land use of areas surrounding the RFETS are described in a vicinity demographics report (DOE 1990) This report encompassed an area within a 50 mile radius from the center of the RFETS and included all or part of 14 counties and 72 incorporated cities with a combined 1989 population of 2 206 500 The largest percentage of the population is located northwest northeast, east southeast and south of the RFETS (refer to Section A 1 1) The current RFETS population consists of approximately 7 600 workers onsite Land use within 0 to 5 miles of the RFETS is divided into urban and suburban residential business/industrial and open space/agricultural Figure A 1 illustrates the current land use in the vicinity of the RFETS

A 1 1 CURRENT LAND USE RESIDENTIAL BUSINESS INDUSTRIAL AGRICULTURAL AND OPEN SPACE

The area west of the RFETS is mountainous sparsely populated and primarily owned by the U S Forest Service The area east of the RFETS is generally a high semiarid plain densely populated and primarily privately owned Most of the population included in the 1990 DOE demographics report is located within 30 miles of the RFETS primarily in the Denver metropolitan area to the east and southeast

The majority of residential users within 5 miles of the RFETS are located to the northwest northeast east southeast and south of the RFETS These population areas are divided into sectors related to distance from the RFETS and representing compass direction in Figure A 2 The actual 1989 residential population and projected population distribution within a 5 mile radius of the RFETS for the year 2010 are presented in Figures A 2 and A 3 respectively The current population for Sectors 1 and 2 (the RFETS and adjacent areas) is zero and projections for population growth indicate that the region will remain sparsely populated (zero growth is anticipated for the next 15 years) (DOE 1990)

Most of Sector 3 and all of Sectors 4 and 5 are located outside the RFETS boundary and are therefore relevant to the offsite residential exposure scenarios As discussed in Section A 1 2 (Future Land Use) these offsite regions are expected to experience significant population increases (See Figure A 3) The total 1989 population for Sector 3 was 51 Sectors 4 and 5 contain the majority of the 1989 population (9 072) within a 5 mile radius (DOE 1990) Segments E through I on Figure A 2 lie in the predominant downwind directions from OU 2 and represent the primary areas potentially affected by airborne contamination from the OU 2 soils (Refer to Section A 3 for wind direction discussions)

Approximately 316 000 people reside within a 10 mile radius of the RFETS The largest residential development is located to the southeast in the cities of Westminster Arvada, and Wheat Ridge The cities of Boulder to the northwest Broomfield Lafayette Louisville and Superior to the northeast and Golden to the south also contain significant residential developments within this 10 mile radius (DOE 1990)

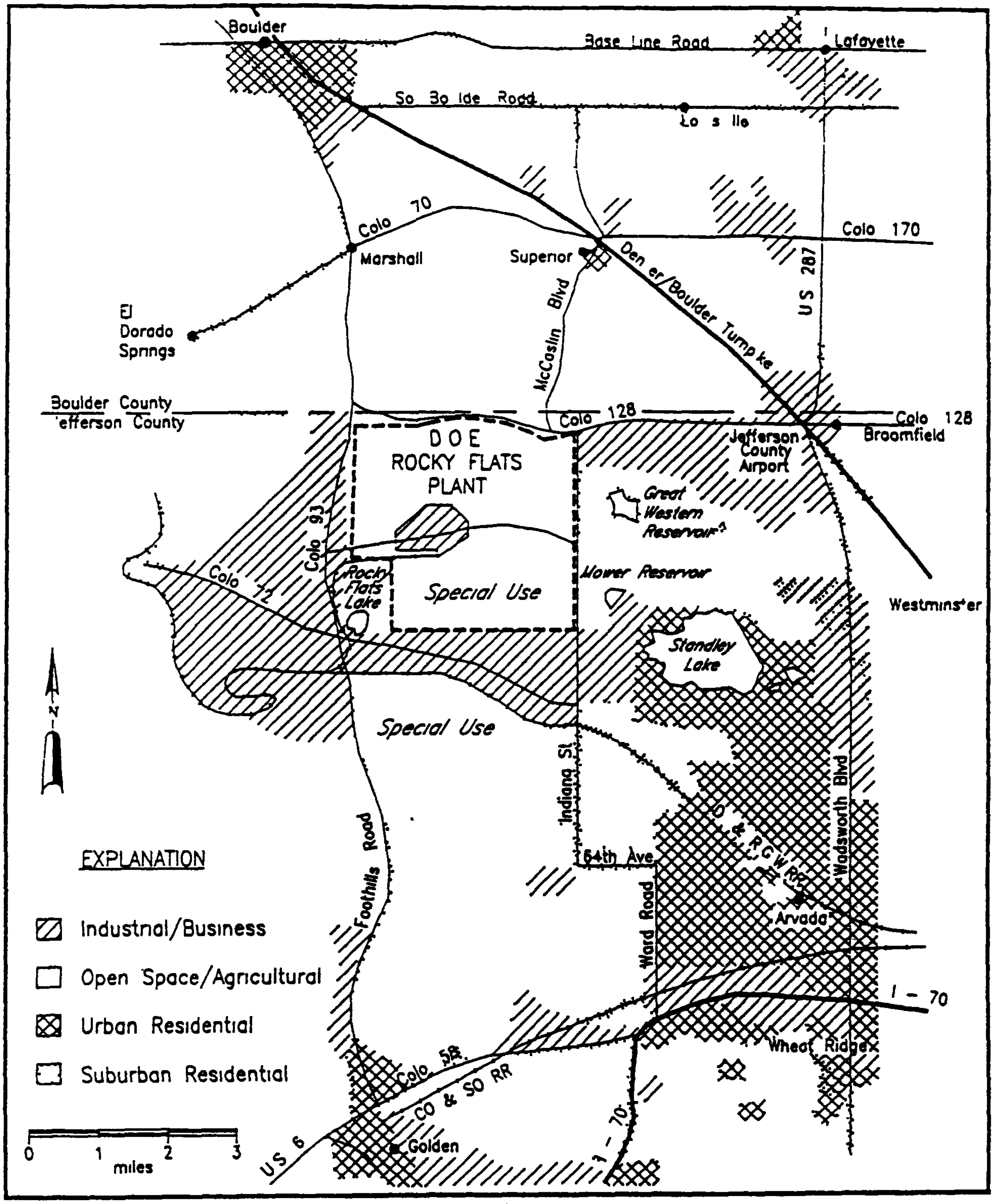
Business/commercial development is concentrated near the residential developments around Standley Lake south and southeast of the RFETS and near the Jefferson County Airport approximately 3 miles northeast of the RFETS Several small businesses are located to the south along State Highway 72

Active industrial land use within 5 miles of the RFETS includes the following operations or activities a sawmill and aggregate company to the north of the RFETS on State Highway 93 a sanitary landfill a paving company and a rock products company south of the RFETS on State Highway 93 and an analytical laboratory a steel fabrication company and a rock and dirt excavation company south of the RFETS on State Highway 72 (EG&G 1991a) Active sand and gravel mines lie within the buffer zone boundaries (DOE 1991d)

There are several inactive mining operations in the vicinity of the RFETS Coal was mined in the region as recently as the 1950s (EG&G 1992c) The Schwartzwalder Uranium Mine is located approximately four miles southwest of the RFETS The mine was once the largest producer of vein type uranium ore in Colorado and ranked among the largest of its type in the United States (DOE 1980 DOE 1991d) The mine was closed in 1989 (Colorado Division of Mines 1992) Clay mining has occurred within the RFETS buffer zone in the past but currently takes place outside of the facility boundaries (EG&G 1992c)

Open space lands are located north and northeast of the RFETS near the city of Broomfield in small parcels adjoining major drainages west along the foothills and as small neighborhood parks in the cities of Westminster and Arvada Standley Lake to the east of RFETS is surrounded by Standley Lake Park

Irrigated and nonirrigated croplands producing primarily wheat and barley are located northeast of the RFETS near the cities of Broomfield Lafayette and Louisville north of the RFETS near Boulder and in scattered parcels adjacent to the eastern boundary of the RFETS (DOE 1992a) In 1987 according to Colorado agricultural statistics 20 758 acres of croplands were planted in Jefferson County and 68 760 acres were planted in Boulder County Other crops grown in the region include corn dry beans sugar beets hay and oats (Post 1989) Irrigated corn and oats are grown north of the RFETS toward Louisville and east of the southern end of Boulder (EG&G 1992c)



(after Jefferso Co ty Plann ng and Zoning Department, April 1990)

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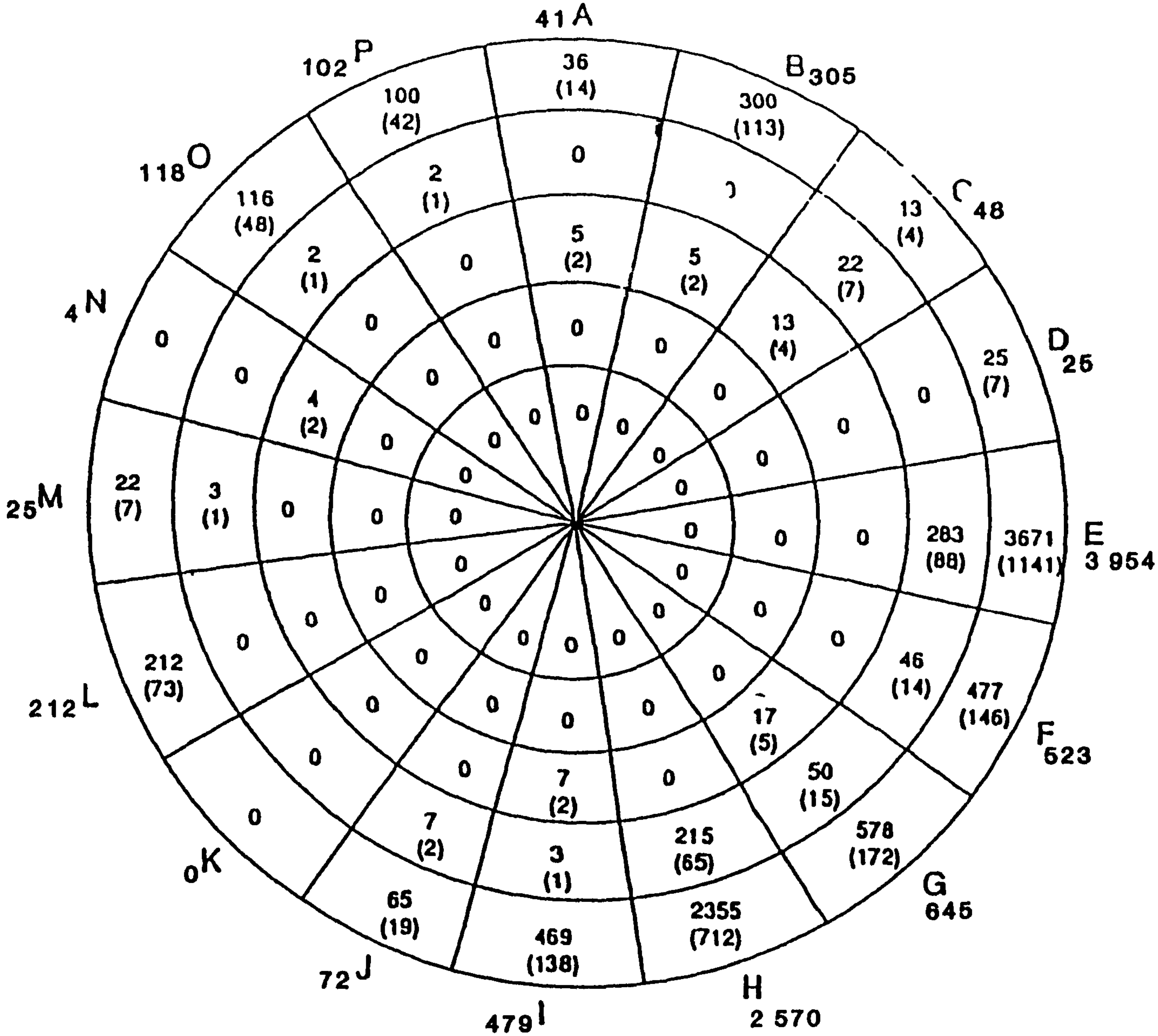
GOLDEN COLORADO

Figure A 1

Operable Unit No 2
Land Use in the Vicinity of the
Rocky Flats Environmental Technology Site

Source DOE, 1991d

r85x11



Miles from RFP Center	Sector Name	Population
0-1	Sector 1	0
1 2	Sector 2	0
2 3	Sector 3	51
3-4	Sector 4	633
4 5	Sector 5	8 439
	Total	9 123

Note The number of households is listed in parentheses for each population

Source DOE. 1990 1989 Population Economic and Land Use Data for the RFP"

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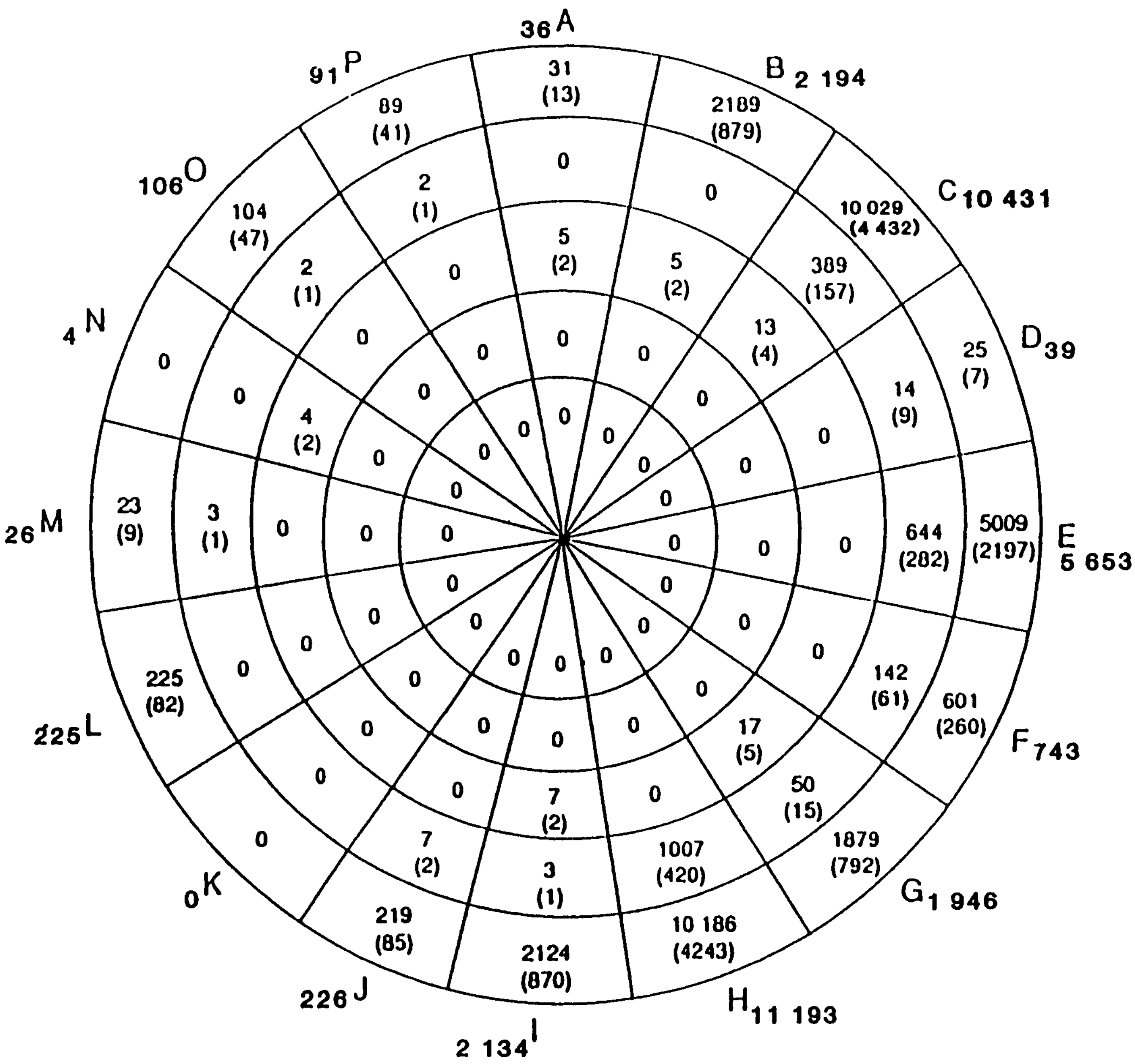
GOLDEN COLORADO

Figure A 2

Operable Unit No 2
1989 Residential Populations and Households within a 5 mile Radius of the Rocky Flats Environmental Technology Site

d65x11h



Source DOE 1990 1989 Population Economic and Land Use Data for the RFP'

Note The number of households is listed in parentheses for each population

Miles from RFETS Center	Sector Name	Popul tion
0-1	Sector 1	0
1 2	Sector 2	0
2 3	Sector 3	51
3-4	Sector 4	2 263
4 5	Sector 5	23 773
		Total 26 087

N t S gm nt C Se t 5 Th P p l tl nd N mber of H s hold al es l l de th p oject d m Im m n mbe of pen y pe mits t be l ed for the Rock Creek housi g d lopm t (4 000 by th y 2000)

S City of S pe l 1994 DRCOG 1994

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GOLDEN COLORADO

Figure A 3

Ope able Unit No 2
Year 2010 Expected Residential Population and Households within a 5 mile Radius of the Rocky Flats En ironment l Technology Site

r85x11h

Livestock ranges are operated within 10 miles of the RFETS and are utilized to raise beef cattle supply milk and breed and train horses (DOE 1991d) Several horse ranching operations and hay fields are located just a few miles south of the RFETS (DOE 1992a)

A 1 2 FUTURE LAND USE

Future land use in the vicinity of the RFETS most likely will involve continued suburban expansion and increased density of residential and commercial land use in the surrounding areas The expected trend in population growth in the vicinity of the RFETS is demonstrated by comparing the 1989 population data to population projections for the year 2010 (DOE 1990) The 21 year population growth profile shows tripling of the population in the vicinity of the RFETS The DOE estimates are based primarily upon long term population projections developed by the Denver Regional Council of Governments (DRCOG) Expected population density and distribution around the RFETS in the year 2010 are shown in Figure A 3

The only major recent (post 1989 DOE population data) housing development within a 5 mile radius of the RFETS is the Rock Creek project in the city of Superior To date 530 occupancy permits have been issued for the project with a maximum of 3 500 to 4 000 single or multi units expected to be constructed This project should be completed by the year 2000 (City of Superior 1994) The city of Superior does not expect any other significant growth in the area since most of the available land has been purchased for strictly open space use DRCOG and the Jefferson County Planning and Zoning Department support this conclusion (DRCOG 1994) (Jeffco 1994)

Several areas of industrially zoned property are located adjacent to and near the RFETS These properties are not likely to be developed in the near future due to the lack of water for fire protection The properties must be admitted to a fire protection district prior to commercial or industrial development To date no fire protection district has been willing to accept the property and it is anticipated that these properties will remain undeveloped in the near future (EG&G 1992c)

A 1 3 POTENTIALLY AFFECTED HUMAN POPULATIONS

The current worker population at the RFETS is approximately 7 600 Most of these workers are involved in light industrial and commercial operations In the near future additional workers will be required for remediation and associated construction activities These activities will range from the sampling of various media at the RFETS OUs to the construction of remedial structures

The school closest to the RFETS is Witt Elementary School approximately 2 7 miles east of the buffer zone (approximately 5 miles from the center of the RFETS) (DOE 1991d) All other sensitive facilities such as hospitals and nursing homes are located beyond the 5 mile radius from the center of the RFETS Ninety three schools eight nursing homes and four hospitals are located within a 5 to 10 mile radius of the RFETS (EG&G 1992c)

The nearest drinking water supply is the Great Western Reservoir located approximately 2 3 miles east of the center of the RFETS The city of Broomfield operates a water treatment facility immediately downstream from the Great Western Reservoir This water treatment facility currently supplies drinking water to approximately 28 000 people The continued use of the Great Western Reservoir as a drinking water source however is limited The city of Broomfield has with DOE s assistance devised a plan to obtain drinking water from other sources distant from the RFETS The city of Broomfield plans to have the alternative water supply selected and functioning by 1997

Standley Lake Park is a recreational area and drinking water supply for the cities of Thornton Northglenn Westminster and Federal Heights The park is located 3 5 miles southeast of the RFETS Water is piped from Standley Lake to each city s water treatment facility Boating picnicking and limited overnight camping are permitted at Standley Lake Park. After 1997 Standley Lake will be the closest drinking water supply to OU 2

A 2 TOPOGRAPHY AND GEOMORPHOLOGY

The following sections briefly describe the topographical and geomorphological characteristics of OU 2 and the RFETS in general

A 2 1 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GENERAL CHARACTERISTICS

The RFETS is situated along the eastern edge of the central Rocky Mountain region immediately east of the Colorado Front Range As shown in Figure A 4 the RFETS is at an average elevation of approximately 5 950 feet above mean sea level (ft msl) The site is located on a broad eastward sloping alluvial surface that has been deeply incised in some areas by modern drainage systems Refer to Section A 4 1 for discussion of the drainage features The surface of the alluvium slopes gently eastward at 88 feet per mile The average elevation along the western RFETS boundary is 6 140 ft msl and slopes to about 5 700 ft msl along the eastern boundary

A 2 2 OPERABLE UNIT 2 SITE CHARACTERISTICS

Section I 2 provides information with respect to the setting of OU 2

A 3 CLIMATOLOGY METEOROLOGY AND AIR QUALITY

The following two subparts of Section A 3 identify the site s climate topography impacts from wind drainage temperature and air quality

A 3 1 RFETS CLIMATOLOGY AND METEOROLOGY

The climate at the RFETS is strongly influenced by the Colorado Front Range The region s semiarid climate is characteristic of much of the central Rocky Mountains Dry cool winters with some snow cover and warm relatively moist summers are typical

Regional topography and upper level wind patterns combine to create a semiarid climate along the foothills of the Colorado Front Range Precipitation in the RFETS area occurs primarily as snowfall or short duration thunderstorms These localized thunderstorms are generally one hour or less in duration and their areal extent is usually limited to approximately one square mile (ASI 1991) Precipitation data are collected and recorded by EG&G at the West Buffer Zone Meteorological Station The 1992 annual precipitation at the RFETS was 14 49 inches (EG&G 1992b) The long term average annual precipitation at the RFETS is approximately 16 inches Although RFETS specific evaporation data are limited the annual net reservoir evaporation rate at RFETS is estimated to be 31 inches (EG&G 1992b)

The orientation of the Front Range affects the local winds Prevailing northwesterly winds are predominant at the RFETS and are normally channeled across the Rocky Flats pediment High velocity winds have been recorded at the RFETS with the highest wind velocities occurring most frequently in the spring Figure A 5 illustrates the RFETS wind frequency distribution for 1990 1991

The RFETS is also affected by westerly drainage winds from the Front Range These air flows channeled through the Front Range canyons are especially pronounced under conditions of strong atmospheric stability Daily cycles of mountain and valley breezes also occur at the RFETS North to south upslope air movement is also typical for the Denver area with air flowing up the South Platte River Valley and entering the Front

Range canyons After sunset, the air cools as it contacts the mountain surfaces and moves downslope Downslope flows converge with the South Platte River Valley flow and move toward the north northeast

Strong surface air convections commonly produce thunderstorms during the summer causing severe and locally unpredictable anomalies in normal air flows Late winter and spring conditions can be influenced by chinook windstorms that move from west to east over the Continental Divide Chinooks have been recorded in excess of 100 miles per hour (mph) at the RFETS (EG&G 1992c)

The temperatures at the RFETS in 1992 averaged a maximum of 77 degrees Fahrenheit (F) and a minimum of 18 F with an annual mean temperature of 48 8 F The recorded RFETS temperature extremes in 1992 ranged from 91 F in July to 4 F in January (EG&G 1992b) The meteorological data were collected at the meteorological tower located in the northwestern buffer zone Infrequent cloud cover over the region allows for intense solar heating of the ground surface The low absolute humidity permits rapid radiant cooling at night Relative humidity averaged 46 percent for the period from 1954 to 1976

Special attention has been focused on the dispersion meteorology surrounding the RFETS due to the potential for significant atmospheric releases of contaminants affecting the Denver metropolitan area Studies of air flow and dispersion characteristics indicate that drainage flows move toward the north and northeast along the South Platte River Valley to the west and north of Brighton Colorado

A 3 2 AIR QUALITY

National Ambient Air Quality Standards (NAAQS) have been promulgated by the EPA in Title 40 CFR Part 50 for six pollutants referred to as criteria pollutants The CDPHE s Air Quality Control Commission has adopted these standards for its compliance program Areas of the state where concentrations of any of the criteria pollutants exceed the NAAQS are defined as non attainment areas

The Denver metropolitan region is considered to be a nonattainment area for the following criteria pollutants carbon monoxide particulate matter less than 10 microns (PM 10) and ozone This nonattainment area encompasses all or parts of Adams Arapahoe Boulder Douglas Denver and Jefferson counties The RFETS is situated in the nonattainment area for all three pollutants

R ne emissions of both radioactive and nonradioactive air pollutants have occurred from the RFETS primarily during past operations These operations were terminated in 1989 greatly reducing the emissions

There were only 12 Air Pollution Emission Notices (APENs see Note [1] below) submitted to CDPHE in 1993 compared to over 200 in 1989 (EG&G 1994) The RFETS emissions for nitrogen oxides are potentially greater than 100 tons per year (TPY) The industrial facilities discussed in Section A 2 1 are also potential sources of air pollution in the vicinity of the RFETS

A 4 SITE AND LOCAL SURFACE WATER HYDROLOGY

Three streams Rock Creek Woman Creek and Walnut Creek drain the RFETS area and generally flow from west to east as shown in Figure A 6 The major drainage basins receiving runoff from OU 2 is South Walnut Creek South Walnut Creek is an intermittent stream with flow occurring primarily after precipitation and snowmelt events A description of these drainages is presented in the following section Figure A 7 presents the routine surface water monitoring locations in the vicinity of the 903 Pad and windblown soil area

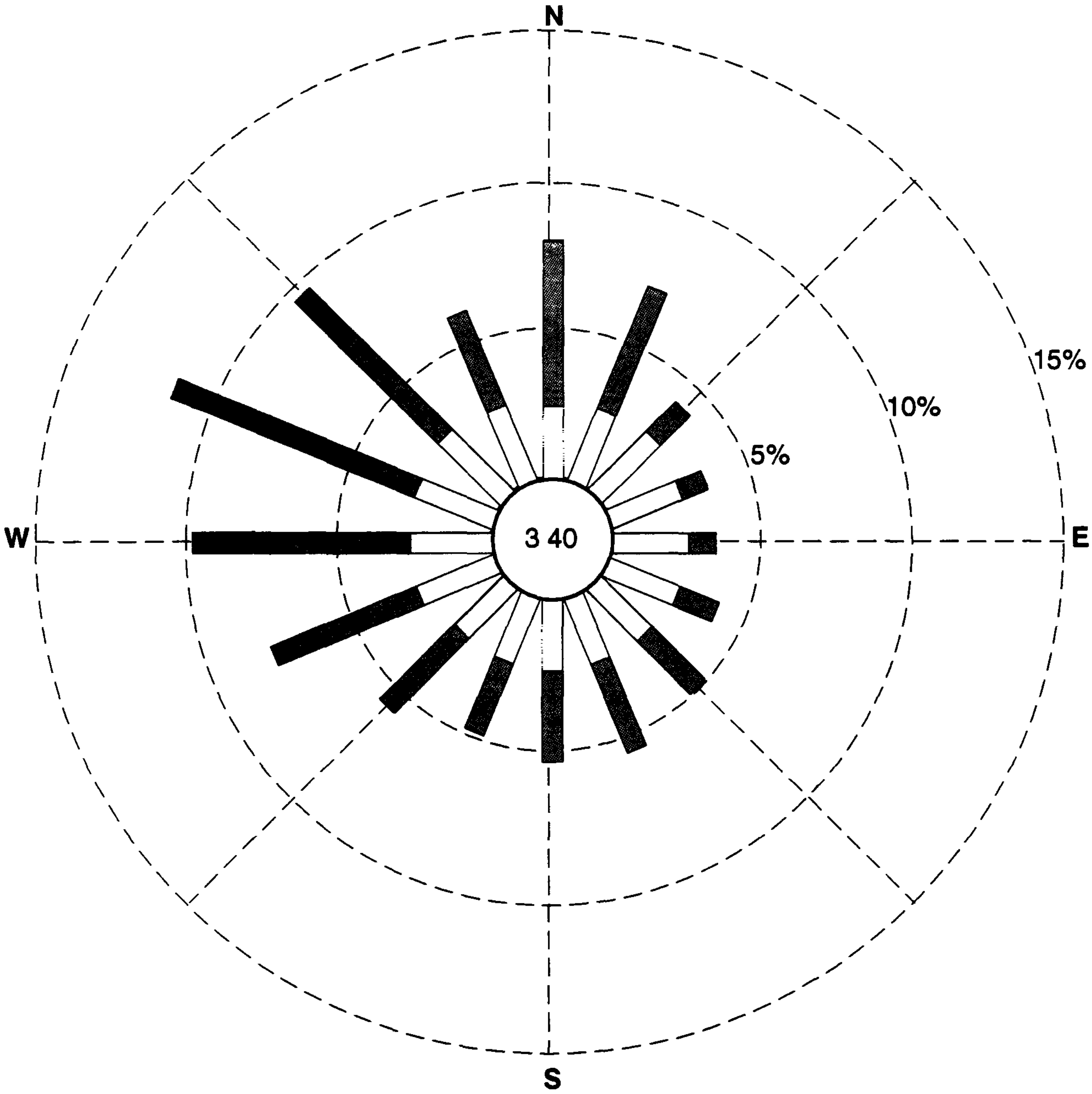
A 4 1 PRINCIPAL DRAINAGE BASINS

Rock Creek drains the northwestern corner of the buffer zone and flows northeastward through the buffer zone to its offsite confluence with Coal Creek Coal Creek flows into Boulder Creek St Vrain Creek and eventually discharges to the South Platte River Rock Creek is peripheral to the RFETS

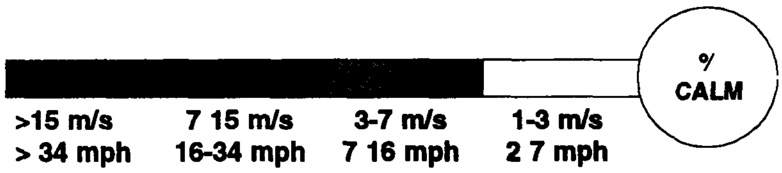
Woman Creek a stream originating west of the RFETS drains the southern buffer zone and flows eastward discharging into Standley Lake Mower Ditch flows from Woman Creek in the eastern portion of the RFETS and supplies Mower Reservoir east of Indiana Street (EG&G 1992e) The South Interceptor Ditch is located between the RFETS and Woman Creek and collects runoff from the southern part of the RFETS and diverts it to Retention Basin C 2 Water from Retention Basin C 2 is pumped treated (if necessary) and discharged in to the Walnut Creek drainage where it flows offsite via the Broomfield diversion canal Most of the remaining surface water runs off into the Woman Creek drainage south of the South Interceptor Ditch Figure A 8 presents the extent of the 100 year floodplain for Woman Creek

Walnut Creek is formed by the combined flows from North Walnut Creek and South Walnut Creek which drain the central and northern areas of the RFETS respectively An unnamed tributary also drains the northern part of the RFETS OU 2 is drained primarily by the South Walnut Creek tributary The three Walnut Creek tributaries join in the buffer zone to form Walnut Creek which flows eastward to the Great

N 1 An A P ll Emissi Notic must be submitted annually to the CDPHE Air P ll u C ntrol D is f any and ll ourc f polluti miss ns An APEN for w urces mus be submitted prior th releas f any emissions



LEGEND



Source 1991 Rocky Flats Plant Meteorological Database

PREPARED FOR
U S DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE
GOLDEN COLORADO

Figure A-5

Operable Unit No 2
Annual Windrose for the
Rocky Flats Environmental
Technological Site 1990-1991

Western R servoir However flow in Walnut Creek is generally diverted around the Great Western Reservoir into Big Dry Creek through the Broomfield Diversion Ditch Figure A 9 presents the extent of the 100 year floodplain for South Walnut Creek

A 4 2 SURFACE WATER CONTROL STRUCTURES

Surface water management controls are in operation at RFETS The West Interceptor Trench diverts runoff from the headwaters of North Walnut Creek via the McKay Ditch Bypass to Walnut Creek west of Indiana Street In addition to ditches and canals a series of retention ponds has been constructed to control the release of RFETS discharges and to collect surface water runoff

South Walnut Creek begins in the RFETS and receives runoff from OU 2 Runoff in South Walnut Creek is collected in Retention Basins B 1 through B 5 The runoff flows overland into the portion of the drainage that is within the Protected Area The runoff enters a culvert system under the Northeast Perimeter Road and flows into a diversion structure located just upstream from Basin B 1 This runoff is normally diverted around Basins B 1 B 2 and B 3 through a bypass line to Basin B 4 although it can be diverted into Basin B 1 Basin B 4 has limited storage capacity and generally passes water directly to Basin B 5

Basins B 1 and B 2 are spill control ponds that receive water from the South Walnut Creek basin Water in Basins B 1 and B 2 is kept at low levels in order to maintain capacity for spill control for the sewage treatment plant (STP) Basin B 3 is discharged to Basins B 4 and B 5 in accordance with the provisions of the NPDES

permit Basin B 5 is the terminal pond on South Walnut Creek Water from Basin B 5 was historically treated and discharged to South Walnut Creek Currently excess water in Basin B 5 is transferred by a new pipeline to Basin A 4 where it is treated (if necessary) and discharged to North Walnut Creek according to the NPDES permit the FFCA and the AIP

A 4 3 SEEPS

Seepage resulting from the discharging ground water has historically been observed on the OU 2 hillside Seeps occur at the interface of the Rocky Flats Alluvium and the Arapahoe Formation

OU 2 PHASE II CMS/FS ALTERNATIVES COST ANALYSIS ROUGH ORDER OF MAGNITUDE (ROM) ESTIMATE ASSUMPTIONS

General

Rough Order of Magnitude estimates were conducted for each alternative The level of detail was limited to this type of estimate

Areas and volumes requiring remediaton are based on the calculations performed on August 23 1995 by E F Krohn Jr and from the Final Screening of Process Options and Detailed Descriptions of Media Specific Alternatives for Operable Unit No 2 report A summary of these values is as follows

Hillside soils Area = 3 1 acres Volume for a 20 cm excavation = 3280 CY

903 Pad Area =3 4 acres Volume of 3 inch thick asphalt layer = 1370 CY Volume for a 40 cm excavation = 7200 CY

Equipment used for the estimate was based on locally available equipment Equipment was limited by the size of the site and of the staging and laydown areas

Delivery Operations Delivery rates were estimated on a maximum frequency of one truck for every 15 minutes due to security checks of the trucks

Onsite Hauling Operations Onsite hauling and handling costs included costs for one off road truck, one front end loader and a water truck

Compaction Costs for compacted lifts are adjusted for a 6 inch lift Therefore the areas were adjusted to reflect the number of required lifts for each soil layer

Productivity Factors Established productivity factors for RFETS have not been incorporated into the estimate

Building Factors were not incorporated into these estimates

Erosion control of the surrounding site was not considered

In determining the present value of each alternative the life of the alternative was 30 years while the interest rate was 3 5 percent A uniform gradient increase was applied to the maintenance cost of approximately 3 5 percent to account for escalation of maintenance costs over the 30 year life of the alternative

No Further Action

Costs were limited to yearly maintenance costs

Institutional Controls

No cost analysis was conducted for this alternative

Enhanced Vegetative Cover

Estimated duration for the entire construction project is 20 weeks

Cover materials will be delivered one week prior to construction activities in the laydown area. Stockpiled materials will allow construction to proceed without delays Stockpiled materials shall be properly segregated

Layers for the enhanced vegetative cover consist of the following

6 5 inches of excavated 903 Lip Area soils

18 inches of 6 inch to 10-inch angular riprap

6 inches of 2 inch to 4 inch angular gravel

Geotextile Fabric

12 inches of clean soil backfill

12 inches of topsoil/gravel admixture

2 inches of pea gravel

surface vegetative cover

903 Lip Area soils will be excavated and transported to the 903 Pad for placement

Onsite Disposal

Estimated duration for the entire construction project is 13 weeks

Onsite disposal shall consist of the following activities

Excavation of the contaminated soils

Transport of the contaminated soils

Storage of the contaminated soils

Monitoring of contaminated soils

Transport of contaminated soils

Disposal of contaminated soils (Tipping fee of $250/CY)

Erosion Control Protection is required prior to construction due to the delayed availability of the onsite disposal facility Onsite disposal could not occur prior to the construction of the onsite CAMU Costs for erosion control were not calculated

Ex Situ Stabilization

Estimated duration for the entire construction project is 22 weeks

Wastech Inc provided estimated costs to stabilize the soils Wastech has demonstrated the ability to stabilize contaminated soils under many conditions including DOE sites

The 903 Pad asphalt layer will be size reduced into fractions less than 3 inches in diameter prior to stabilization

Course grained soil particles greater than 1 inch in diameter shall be separated and returned to the excavation prior to stabilization Dry separation techniques were incorporated It was estimated that 20 percent (by volume) of the soil would be > 1 inches

It was estimated that the volume increase following stabilization would be 20 percent.

Stabilized soils were returned to the original excavation

24 inches of subsoil (topsoil/gravel admixture) shall be placed on the stabilized soils 6 inches of topsoil shall be placed on top of the subsoil to support vegetative growth

OU 2 PHASE II CMS/FS ALTERNATIVES COST ANALYSIS

ROUGH-ORDER-OF-MAGNITUDE (ROM) ESTIMATE

NO FURTHER ACTION

T k N	Tas Description	Quantity	Units	Labo Unit Price	Labo Am nt	Matenals Unit Price	Matenals Amo nt	Equipment Unit Price	Equipment Amount	Subcont act Unit Price	Subcont act Amount	Total Am unt
	INDIRECT COSTS											
	NONE REQUIRED											
	DIRECT FIELD COSTS											
	NONE REQUIRED											0
											TOTAL CAPITAL COST	0

T sk N	Task Description	Quantity	Units	Labor Unit Price	Labor Amount	Matenals Unit Price	Matenals Amount	Equipment Unit Price	Equipment Amount	Subcontract Unit Price	Subcontract Amount	Total Am unt
	YEARLY MAINTENANCE COSTS											
	SAMPLING AND ANALYSIS	40	EACH	20	800							800
	RAD SURVEY	4	EACH	4800	9 200							19,200
	SITE INSPECTION	24	EACH	320	7 680							7 680
											Sub Total of Costs	31 680
	OTHER YEARLY MAINTENANCE COSTS											
	SAMPLING AND ANALYSIS	40	EACH					40	1 600	000	40 000	41 600
	SUBTOTAL								1 600		40 000	41 600
	PROCUREMENT RECOVERY ON MATERIALS (8%)								128		3,200	3,328
											SUBTOTAL	44 928
	SITE G&A (13 8%)											6 200
											SUBTOTAL	51 128
	SITE SUPPORT (38%)											19 429
											SUBTOTAL	70 557
	COMPANY G&A (16%)											11 289
											Sub Total of Other Costs	81 846
											CATEGORY SUBTOTAL	13,526
	CONTINGENCY (35%)											39 734
											TOTAL YEARLY MAINTENANCE COST	153 260
											TOTAL PRESENT VALUE	3 391 032

PRESENT VALUE CALCULATION

General Information:
Capital cost 0
Yearly Maintenance Cost $153 260
Life of Alternative (n) 30 years
Annual Inflatio Rate () 3 5 percent
Uniform Gradient Increase in Maintenance $2,600

Present Value of Yearly Maintenance
(P/A) (P/G)
P A(P/A,r%,) G(P/G r%,)
$153,260(18.3920) $2,600(220 1056)
$3 391 032

OU 2 PHASE II CMS/FS ALTERNATIVES COST ANALYSIS

ROUGH-ORDER-OF-MAGN TUDE (ROM) ESTIMATE

ENHANCED VEGETATIVE COVER

ak No	ak Description	Quantity	Uni	Labo Uni Pri	Labo Amoun	Material Uni rice	Material Amoun	Equipmen Un Price	Equipmen Amoun	Subcontract Uni rice	Subcontract Amoun	otal Amoun
	INDIRECT COSTS											
	RAINING	600	MH	66	80							39 80
	ET AGING AREA	40	MH	96								8
	ET UP EX LU Z NES	40	MH	96								
	DECON W SH AREA	20	D S	96	936							936
	MOBILIZATIO	20	MH	96								
	GEOTECH TECHNICIAN	540	MH	95 26	440							440
	RAD TECHNICIANS	60	MH	92 42								8
	QUALITY ASSURANCE	00	MH	95 29	29							9 529
	DEMOB/SITE CLEAN-UP	320	MH	96	30							30 70
											Sub Total of Indirect Cost	67 798
	OTHER INDIRECT FIELD COSTS											
	DEED RESTRICTIONS		EACH							50 000	50 000	50 000
	SET UP LAYDOWN AREA		LS								000	000
	DECON WASH AREA	20	D YS						000			0 000
	SANITARY	5	MONTHS					580	2 800			2,800
	HEAL AND SAFETY SUPPLIE		LS								20 000	20 000
	MOBILIZATIO	20	MH				5 000					000
	MOBILE GEOTECH LAB		MONTHS							700	2 00	2 00
	AIR MONITORING		LS								25 000	25 000
	FINAL SITE SURVEY		LS								2,000	2 000
	SUBTOTAL						000		2 800		08 00	28 900
	PROCURE ENT RECOVERY ON TERIALS (8%)						400		024			42
											SUBTOTAL	28 32
	ITE G&A (8%)											7 709
											SUBTOTAL	46 033
	SITE SUPPORT (38%)											58 492
											SUBTOTAL	20 525
	COMPANY G&A (6%)											32,244
											Sub Total of Other Indirect Cost	233,769
											CATEGORY SUBTOTAL	40 567
	ESCALATION (3.72%)											938
											SUBTOTAL	8 505
	CONTINGENCY (35%)											45 777
											Total of Indirect Costs	562 282

ENHANCED VEGETATIVE COVER (CONTINUED)

<u>DIRECT FIELD COSTS</u>								
<u>VEGETATION REMOVAL</u>								
E ET TION REMO AL	2500 CY	2 00	000			50	50	50
URFACE PREPARA	5 000	05	50				250	000
<u>MOVE HILLSIDE SOILS</u>								
	3280 CY	50	20			00	60	200
RA PORT	80	00	580			50	20	480
GRADE SO	000	05	50			5	2 50	000
OM AC SOILS	600	00	600			50	800	29 400
VERY AC FILL	600 CY			27	22.572			22 572
GRADE BACKFILL	000 SY	00	5 000			50	500	22 500
<u>INSTALL VEG. COVER</u>								
DELIVER OF RIPRAP	00 CY			28	77			77
GRADE RI RAP	60 000	05	000				000	000
DELIVER OF GRAVE	3250 CY				48			48
GRADE GRAVEL	380	05	968				2 904	2
DE VERY GE EXTILE	380 SY			80	34 848			34 848
LACEMENT GEOTEXTILE	380		520			45	7 2	3,232
E VERY ACK LL	6500 CY			27	40 58			40 758
GRADE BACKFILL	40 000 SY	05	000			0 5	8 000	000
COM ACT BACKFILL	380 SY	00	380			50	9 680	29 040
DELIVERY F TOPSOIL/GRAVEL	6500 CY			03	23 895			23 895
GRADE TOPSOIL/GRAVEL	40 000 SY	00	40 000			0 50	20 000	60 000
DELIVERY OF EA GRAVEL	00			5	050			050
GRADE PEA GRA E	380 SY	05	968			5		968
NSTALL PERIMETE FENC NG	3400 LF	50	2 900	0	380			48 280
<u>SEEDING</u>								
ENGINEERED COVE AREA	ACRE					2 500	000	0 000
EXCA HILLS DE	ACRE					2 500	0 000	000
<u>Subtotal of Direct Costs</u>								758 938
<u>CONTRACTOR MARK-UPS</u>								
CONTRACT R AN SUB-CONTRACTOR OVERHEAD PROFIT (35 %)								26 88
SCALATI (72%)								38 098
ROCUREMENT REC VERY (3%)								3 867
							<u>SUBTOTAL</u>	094 098
SITE G&A (13.8%)								50 986
							<u>SUBTOTAL</u>	245 084
SITE SUPPORT (38%)								3 32
							<u>SUBTOTAL</u>	7 8,2 6
CO ANY G&A (8%)								27 5
							<u>SUBTOTAL</u>	993
CONT NGENC (35%)								697 590
							TOTAL CAPITAL COST	253,008

ENHANCED VEGETATIVE COVER (CONTINUED)

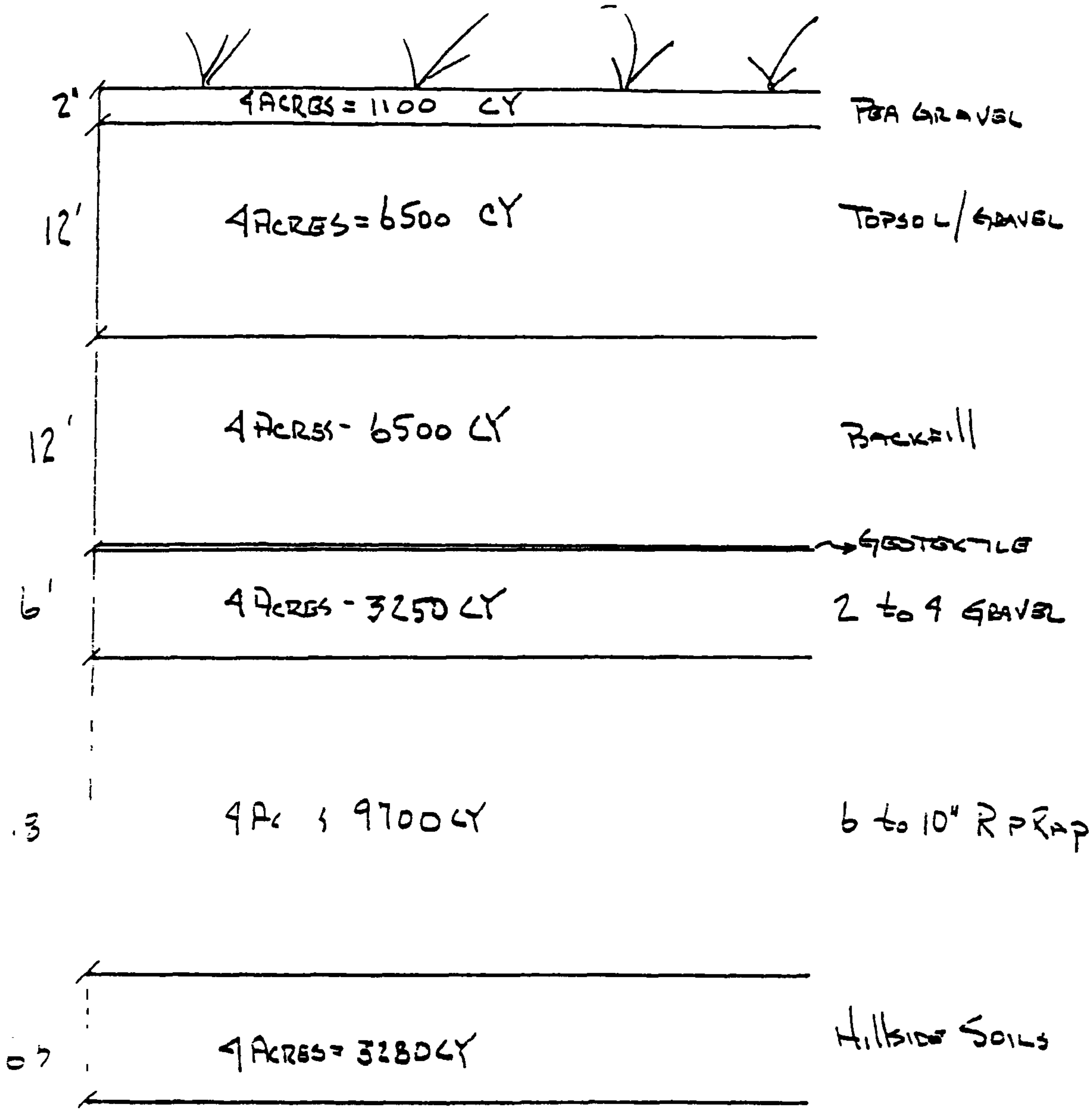
ask No	ask Description	Quantity	Units	Labo Un ce	Labo Amoun	Materials Uni rice	Materials Amoun	Equipmen Unit Price	Equipmen Amount	Subcontract Uni rice	Subcontract Amoun	otal Amoun
	YEARLY MAINTENANCE COSTS											
	AMP NG AND ANAL	40	EACH	20	800							800
	RA URVEY		EA	4800	200							200
	SITE TIO		EACH	20	680							7 680
	MOWING ERA IO		EAC	320	320							320
	ITE EPAI		EAC	640	640							640
											Sub Total of Costs	32 640
	OTHER YEARLY MAINTENANCE COSTS											
	AMPLING AND ANAL SI	40	EACH					40	600	000	40 000	600
	E MOWING OPERATIONS		EACH					60	60			60
	ITE EPAIRS		EAC					400	400		000	400
	SUBTOTAL								90		49 000	5 60
	PROCUREMENT RECOVERY ON MATERIALS (8%)								73		920	083
	SUBTOTAL											56 253
	SITE G&A (%)											25
	SUBTOTAL											62 78
	ITE SUPPORT (38%)											23 864
	SUBTOTAL											86 77
	COMPANY G&A (6%)											883
											Sub Total of Other Costs	00 655
											CATEGORY SUBTOTAL	33 295
	CONT NGENCY (35%)											46 65
											OTAL YEARL MAINTENANCE COST	79 948
											OTAL PRESENT ALUE	200

PRESENT VALUE CALCULATION

General information
Capital Cost $3,253 008
early Maintenance Cost $ 948
Life of Alternative (n) 30 years
Annual flation Rate ( ) percent
Uniform Gradien Increase Maintenance $2,900

Present Value of Yearly Maintenance
'P/A,) (P/G,)
A(P/A,i%) G(P/G I%)
$ 79,948(3920) $2 900(220 066)
$3 94 909

Vegetating Cover



OU 2 PHASE II CMS/FS ALTERNATIVES COST ANALYSIS

ROUGH-ORDER-OF-MAGNITUDE (ROM) ESTIMATE

EXCAVATION AND ONSITE DISPOSAL

			Labo		Ma na		pmen		Subcon ac		
sk No	Desc p on	Quan ty Un	Un	Amou	Un	Amou	Uni	Amou	Un c	Amou	Amou
	INDIRECT COSTS										
	NG	00		80							
	ET		96								
	ET	40	96								
	W AR	20 D	96								36
	MO	20	96								
	AD	20		090							090
	TV RAN	00									
	EMOB/SITE LE N-	20 MH	96	30							
										Subtotal of Indirect Costs	
	OTHER INDIRECT FIELD COSTS										
	E CTIO	EA							50 000	50 000	000
	ET LA DOW E	S								000	000
	W RE	20						000			000
	IT	MONT					560	680			680
	ETY UP									000	000
	MOB IZ TI	20 MH				000					000
	NG									30 000	30 000
	ING	50							50	982 500	2 982 500
	EY									000	000
	SUBTOTAL					000		80		06 00	
	OC ENT TERI LS (%)					400		34			
										SUBTOTAL	08
	IT G&A (%'										26 77
										SUBTOTAL	5
	E '38%										335
										SUBTOTAL	848 56
	NY G&A (%)										77 80
										Sub Total of Other Indirect Costs	
										CATEGORY SUBTOTAL	
	ES LAT (2%)										
										SUBTOTAL	950
	NT NG NCY (38%)										2 08 72
										INDIRECT TOTAL COSTS	36

EXC VATION AND ONSITE DISPOSAL (CONTINUED)

	DIRECT FIELD COSTS														
	REMOVE HILLSIDE SOILS														
	PT NCE RITERI NG														
	E SO				20					00	80				00
	RT			00	60					50	20				480
	NG RA PORT													480	80
	LL	00						22							2
	RA E KFILL	000			50						2				000
	REMOVE 903 PAD AND SOILS														
	EX E P AL LS			50	55					00					2 42
	RA AL			00	40					50					99
	ER HA NG OR TRA PORT	5												20	
	LL	500 CY						56							56
	RA B LL	50 000		05	500						500				000
	SEEDING														
	903	E								500	000				000
	ED HILL DE	ACRE								500	000				000
	Subtotal of Direct Costs														83
	CONTRACTOR MARK UPS														
	CONTRACT AND UB-CONTRACT VERHEAD RO IT (35 3%)														32
	ALA O (2%)														8 6
	ROC NT EC VERY (3%)														82
														SUBTOTAL	
	G&A (%)														36
														SUBTOTAL	
	E UP (38%)														
														SUBTOTAL	
	NY G&A %)														36 50
														SUBTOTAL	638
	ONT NGENC (35%)														
														OTAL APITAL ST	36

			Labo			Materials			Equipmen			Subcontrac			tal
ak No	Task Description	Quan ty Uni	Uni	ric	Amoun	Uni	rice	Amoun	Unit	rice	Amoun	Uni	rice	Amoun	Amoun
	YEARLY MAINTENANCE COSTS														
	NO EXPECTED														
												OTAL YEARL MAINTENANCE COST			

PRESENT VALUE CALCULATION

General Information
Capital Cost $8 369
early Maintenance ost
Altern tive ( ) ndefinite
Annu ion Rate ( ) N/

Present Value of Yearly Maintenance
N/

O AL PRESENT ALUE $ 36

OU 2 PHASE II CMS/FS ALTERNATIVES COST ANALYSIS
ROUGH-ORDER OF-MAGNITUDE (ROM) ESTIMATE
INSTITUTIONAL CONTROLS

T No	Descriptio	Q an ity	ts	ab Pnce	mo nt	M te nc	Amo	Eq pment Pnce	Amo	S Un Pnc	mo nt	T ta Am nt
	CAPITAL COSTS											
	DIRECT FIELD COSTS											
	T E METER F¯NC G	000	F		00	5	2 00					56 800
	ST LL S GNS	40	EAC			00						2
											SUBTOTAL	5 40
	CONTRACTOR MARK UPS											
	CONTRACTOR AND S B-CONTRAC¯OR O ERHEAD & PROFIT (35 3%)											20 35
	ESC LATIO (3 2%)											2 8
	PROC REMENT RECOVERY ' %)											2 40
											SUBTOTAL	8
	SI¯E G&A ' %)											3 8
											SUBTOTAL	93 82
	SITE SUPPORT (38%)											35 65
											SUBTOTAL	29 79
	COMPANY G&A (%)											20 7 7
											SUBTOTAL	50 95
	CONTINGENC (35%)											52 568
											TOTAL CAPITAL COST	202 784

T No	T Descrip	Quan ity	its	U	ab Pnc	Amo nt	Un	M teria Pnc	Amo nt	U	E pment Pnc	Amount	Un	Subc Pnce	act Amount	T ta Amount
	YEARLY MAINTENANCE COSTS															
	SAMPL NG AND ANALYS S	40	EACH		20	800										800
	S TE NSPECTION	2	EAC		320 00	3 840										40
	SITE REPAIRS		EACH		640 00	640										640
															Sub Total of Cost	9 280
	OTHER YEARLY MAINTENANCE COSTS															
	SA P NG AND ANALYS S	40	EAC								40	600		000	40 000	00
	SITE REPA RS		EACH					00 00	00							00
	SUBTOTAL								00			600			40 000	700
	P OCUREMENT RECOVERY ON MATERIALS P RCHASED (%)								8			28				36
															SUBTOTAL	836
	S E G&A (%)															773
															SUBTOTAL	609
	SITE SUPPORT (38%)															92
															SUBTOTAL	
	COMPANY G&A (16%)															2
															Sub Total of Other Cost	6 2
															CATEGORY SUBTOTAL	5 93
	CONTINGENCY (35%)															29 923
															TOTAL YEARLY MAINTENANCE COST	5 6
															TOTAL PRESENT ALUE	229 930

PRESENT VALUE CALCULATION

General Information
Cap al cost $202 784
Yearly M inten nce Cost $ 5 6
ife of Alternatv ( ) 30 ears
An ual nflation Rate () 5 percent
U if rm G adent Increase Maintenanc $ 500

Present Value of Yearly Maintenance
(P A) (P/G)
P A(P A,i%) G(P/G,i%,)
-$ 54 (5 3725) $ 500(68.6229)
$2,027 66

(*Lepus townsendii*) deer mouse (*Peromyscus maniculatus*) western harvest mouse (*Reithrodontomys megalotis*) and meadow vole (*Microtus pennsylvanicus*) (DOE 1980)

Commonly observed birds include the horned lark (*Eremophila alpestris*) western meadowlark (*Sturnella neglecta*) mourning dove (*Zenaidura macroura*) vesper sparrow (*Pooecetes gramineus*) western kingbird (*Tyrannus verticalis*) black billed magpie (*Pica pica*) American robin (*Turdus migratorius*) English sparrow (*Passer domesticus*) house finch (*Carpodacus mexicanus*) Say s phoebe (*Savornis saya*) barn swallow (*Hirundo rustica*) starling (*Sturnus vulgaris*) and yellow warbler (*Dendroica petechia*) Mallards (*Anas platyrhynchos*) and other ducks (*Anas spp*) often nested on several of the SEPs when they were in operation Killdeer (*Charadrius vociferus*) and red winged blackbird (*Agelaius phoeniceus*) are found in areas adjacent to the SEPs Birds of prey commonly seen in the area include the marsh hawk (*Circus cyaneus*) red tailed hawk (*Buteo jamaicensis*) ferruginous hawk (*Buteo regalis*) rough legged hawk (*Buteo lagopus*) American kestrel (*Falco sparverius*) swainson s hawk (Buteo swainsoni) and the great horned owl (*Bubo virginianus*) (DOE 1980)

Rattlesnakes (*Crotalus viridis*) and bullsnakes (*Pituophis melanoleucus*) are the most frequently observed reptiles Eastern yellow bellied racers (*Coluber constrictor falviventris*) have also been observed The eastern short horned lizard (*Phrynosoma douglassi*) has been reported on the site but these and other lizards are not commonly seen The western painted turtle (*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds on the RFETS property (DOE 1980)

Rocky Flats Environmental Technology Site Threatened and Endangered Species

American Peregrine Falcons (*Falco peregrinus*) and Bald Eagles (*Haliaeetus leucocephalus*) federally listed as endangered species are observed seasonally at the Site A pair of Peregrine Falcons has nested in the Flatirons a few miles to the northwest of the Site for several years This species uses the Buffer Zone as casual foraging range during the spring summer and fall Numbers of wintering Bald Eagle have been increasing along the Front Range for the past several years Observations of the species at the Site and within the vicinity have increased since the Baseline Study (DOE 1992) Observations during 1993 (DOE 1994a) and 1994 (DOE 1995a) showed an increase in observations on site The Site is considered an opportunistic foraging area for Bald Eagles The only Bald Eagle nest in the Rocky Flats vicinity is at Standley Lake and to date it has not yet been used for a brood Indications are however the locale may eventually be used to raise a brood of Bald Eagles

Three Colorado Species of Special Concern occur at the Site Long billed Curlews (*Numenius americanus*) are casual visitors to the site during migration (DOE 1995a DOE 1994a) The Site is not within traditional summering or breeding grounds but suitable foraging habitat exists Greater Sandhill Cranes (*Grus canadensis tabida*) are frequently observed flying over the Site during spring and fall migrations (DOE 1992 DOE 1994a DOE 1995a) While suitable foraging habitat exists and stop overs may occur at the Site no individuals of this species have been observed on the ground foraging American White Pelicans (*Pelecanus erythrorhynchos*) have been observed at several impoundments on the Site during the spring and summer seasons (DOE 1992 DOE 1994a, DOE 1995a)

References for Threatened and Endangered Species Section

DOE 1995a 1994 Annual Wildlife Survey Report Natural Resources Protection and Compliance Program Golden Colorado April 24 1995

DOE 1995b Rocky Flats Environmental Technology Site Ecological Monitoring Program 1995 Annual Report Golden Colorado May 31 1995

DOE 1994a Resource Protection Program Annual Wildlife Survey Report. Golden Colorado April 29 1994)

DOE 1994b Ecological Monitoring Program Annual Report Golden Colorado January 21 1994

DOE 1992 Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at Rocky Flats Plant Golden Colorado September 1992

ESCO 1994 Report of Findings Ute Ladies Tresses and Colorado Butterfly Weed Surveys Rocky Flats Buffer Zone Jefferson Co Colorado September 13 1994

ESCO 1993 Report of Findings Ute Ladies Tresses and Colorado Butterfly Weed Surveys Rocky Flats Buffer Zone Jefferson Co Colorado September 24 19934

RMRS 1995 Special Concern Species for the Rocky Flats Environmental Technology Site Golden Colorado September 20 1995 (A list.)

References for Senstive Habitats (Riparian Corridors, Wetlands, and Associated Habitats)

EG&G 1993 Draft Rocky Flats Plant Wetlands and Wildlife Habitat Mitigation Plan Golden Colorado April 1993

U S Army Corps of Engineers 1994 Rocky Flats Plant Wetlands Mapping and Resource Study Omaha District December 1994

A 9 SOCIAL AND ECONOMIC RESOURCES

The following 4 subparts to A 9 detail the site s potential for future use based on cultural response surveys visual resources recreational possibilities and public road access

A 9 1 SITE LOCAL CULTURAL AND ARCHEOLOGICAL RESOURCES

Two large scale and at least two small scale cultural resource surveys have been completed for 5 900 acres of the RFETS (EG&G 1992c) Areas excluded from survey were the inner RFETS zone now known as the Protected Area and all designated solid waster management units These surveys recorded 37 cultural resource sites and 26 isolated finds Thirty five sites were dated from the 1870s through the mid 1900s and were associated with agriculture and ranching Ditches stock watering ponds building remains a trash dump rock piles corrals and an orchard are examples of historic sites (EG&G 1992c) Two Native American occupation sites were also recorded These sites consisted of low circular rock piles and a series of linear stone alignments No artifacts were associated with either of these sites The 35 historic sites do not qualify for eligibility on the National Register of Historic Places and no eligibility recommendations have been made for the two Native American sites (EG&G 1992c)

A 9 2 VISUAL RESOURCES

The region around the RFETS offers a variety of scenic experiences to users of the area due to the diversity of the topography and geologic formations characteristic of Colorado s Front Range The RFETS location also provides a scenic view of the Denver metropolitan area. The RFETS and the OU 2 area are not considered to have the scenic attributes of the surrounding natural region The RFETS does not contain distinctive landscape features to distinguish it from adjacent landscapes The landscape scenic quality for the RFETS is common in classification (EG&G 1992c)

Colorado State Highways 72 93 and 128 along with Jefferson County Highway 17 provide the primary views from travel routes These highways as well as being the principal transportation routes are also the dominant human made features surrounding the RFETS The numerous structures on the RFETS property constitute the other highly noticeable human made features in the area.

A 9 3 RECREATION

There are several recreational areas in the general vicinity of the RFETS including Standley Lake Park Boulder Mountain Park Jefferson and Boulder Counties open spaces and other public lands Much of the recreational activity involves hiking climbing biking and other opportunities common to large expanses of public land Hunting and fishing are not allowed in any areas around the RFETS No recreational activities are allowed within the RFETS boundaries and public access to the facility is restricted

A 9 4 TRANSPORTATION

The primary transportation routes through the region are Colorado State Highways 72 93 128 and Jefferson County Highway 17 Numerous county and other roads exist in the residential and commercial areas to the north east and south of the RFETS The heaviest traffic volume is on weekdays during the morning and evening rush hours The 20 year traffic projection for the area north and south of the intersection of State Highways 72 and 93 is 22 000 average daily traffic (ADT) and 20 000 ADT respectively (DRCOG 1994)

Access to the RFETS property is attained by turning west from Indiana Avenue onto the East Access Road or by turning east from Colorado Highway 93 onto the West Access Road (EG&G 1992c)

Central Avenue (paved) runs along the northern extent of OU 2 A dirt road runs along the southern extent of OU 2

Table B 1
OU 2 Dose Based PRGS Based on BRA for 15 mrem/yr Goal

Assumptions

Variable Description	Units		CT Value Office Worker	CT Value Open Space Adult/Child
Exposure Frequency	days/yr	EF	219	10
Exposure Time	hr/day	ET	7 2	1 5
Daily Inhalation Rate	m3/hr	IRa	63	83
Exposure Duration	y	ED	1	1
Particulate Emission Factor	m3/kg	PEF	7 20E+07	7 20E+07
Soil Ingestion Rate	mg/day	IF	5	86
F action Soil from Contaminated Source		FSCS	1	1
Gamma Shielding Factor		Se	5	2
Gamma Exposure Factor		T		1
Dose Goal	mrem/yr	dDG	5	5
Respirable F action		RF		1
Respiratory Deposition Factor		RDF	0 851	0 86
Ingestion Rate Surface Water/Wading	L/hr	IRW	0	0
Wading/Surface Rate	hr/visit or hr/day	WR	0	0 5
Wading/Surface Exposure Frequency	visit/year or days/yr	WRF	0	5
Water to Soil Contamination Ratio		WSCR		

anable Description	Units		RME Value Office Worker	RME Value Open Space Adult/Child		
Exposure Frequency	days/y	EF	250	25		
Exposure Time	hr/day	ET	8	5		
Daily Indoor Inhalation Rate	m3/hr	IRa	83	1	64	7
Exposure Duration	y	ED			L L 0"	M 1 M10"
Particulate Emission Factor	m3/kg	PEF	7 20E+07	7 20E+07		
Soil Ingestion Rate	mg/day	IF	50	60		
F action Soil from Contaminated Source		FSCS				
Gamma Shielding Factor		Se	2			
Gamma Exposure Factor		T				
Dose Goal	mrem/y	dDG	5	5		
Respirable F action		RF		1		
Respiratory Deposition Factor		RDF	1	1		
Ingestion Rate Surface Water/Wading	L/hr	IRW		0		
Wading Rate/Surface Water	hr/visit or h /day	WR				
Wading/Surfac Exposure Frequency	visit/year or days/yr	WRF	0	15		
Water to Soil Contamination Ratio		WSCR	1			

Radionuclide	Inhalation EPA Dose Factor (Sv/Bq)	Ingestion EPA Dose Factor (Sv/Bq)	Inhalation EPA Dose Factor (em/uCi)	Ingestion EPA Dose Factor (rem/uCi)
P 239	33E-05	1 40E 08	3 08E+02	5 8E-02
P - 40	33E 05	40E-08	3 08E 02	5 18E-02
Am-2	20E-04	9 84E 07	4E+02	3 64E+00

S2 700000"

T2 700000"

This number would normally ary as function of work activities and site conditions, typically done using esuspension factors

The PEF as calculated based on the assumed soil concentration and the air concentration based on modeling discussed the BRA

Table B 1 (continued)

Effective Dose Equivalent Factor (50 Years) (em/uCi)

Radionuclide	Pu-239	Pu-240		U-238	Th-234	Am-241	[redacted]	
Inhalation	3 08E+02	3 08E+02	1 30E+02	120	0 00E+00	4 44E+02	1 20E+02	0 00E+00
Ingestion	5 18E-02	5 8E-02	2.80E-02	2 30E-01	0 00E+00	3 64E+00	2 50E-01	0 00E+00
							(em/y)/(pCi/g)	
External								
Surface	3 48E-08	7 54E-08	7 42E-08	9 89E-05	NA	2 75E-04	1 75E-03	NA

Note Pu nd Am inhalation nd ingestion dose factors based ng V lues of Intake nd Air Concent tion nd Dose Conversion for Inhala ion, Submersio and I gestion (Fede l Guidance Report No 11) Since the ther adionuclide ar not addressed in the BRA, they e still based on DOE/EH-0071 Note the differences are not actually significant

Uptake Characteristics

Inhalation	Ingestion	Element
Y	1 00E-05	Plutonium
W	1 00E-03	Americium

	K1	K2	KX
PRG Calculatio	=F u 10*F$11 F$19*F$2 0*F$ 2/F $13	=F$ 000001 F$14	=F$12*(1 F$16) F$17* F$9*0 F 0/24 1000 F9/365

Based on RME V lues

K1	K2	KX
=L$9*L$1 0*L$11 L$ *L$20*L $12/L$13	=L$12 L$9*0 00000 L$	=L12*(1 L 6)*L 7*L 0/2 4 1000*L9/365

Based on CT V lues

	K1	K2	KX
Office Worker	1 17E-05	1 10E-03	9 00E+01
Open Space	1 47E-07	8 60E-04	1 37E+00

	K1	K2	KX
Office Worker	2 31E-05	1 25E-02	1 83E+02
Open Space	2 43E-06	1 50E-03	1 43E+01

						Open Space
Pu-239	3 68E-03	3 13E-04	3.78E+03	8.98E-05	4 78E-06	58E+05
Pu-240	3 68E-03	6 79E-04	3 44E+03	8.98E-05	1 03E-05	50E 05
U 234	1 55E-03	6.68E-04	6.75E+03	4 15E-05	1 02E-05	2 80E+05
U-235	1 68E-03	1 57E-01	9.43E+01	2 33E-04	2 40E-03	5 71E+03
U-238	1 68E-03	8.90E-03	1 42E+03	2.15E-04	1 35E-04	4 28E+04
Am-241	9 20E-03	2.48E-02	4 42E+02	3.20E-03	3.77E-04	4 20E+03

PRG Calculation for RME

Radionuclide			Office Worker			Open Space
Pu-239	7 75E-03	6 35E-04	1 79E+03	8 27E-04	4 96E-05	1 71E 04
Pu-240	7 75E-03	1 38E-03	1 64E+03	8 27E 04	08E 04	1 6 E 04
U-234	3 32E-03	1 36E-03	3 21E+03	3 55E-04	1 06E 04	3 25E 04
U-235	5 89E-03	3 19E-01	4 61E+01	6.67E-04	2 50E-02	5 85E+02
U-238	5 64E-03	1 81E-02	6 33E+02	6 37E-04	1 41E 03	7 33E 03
Am 241	5 57E-02	5 02E-02	1 42E 02	6 54E-03	3 93E 03	1 43E 03

The ingestion of surface water not included in the evaluation since, based on the BRA, it is not significant contributor to the dose

=($C49*$D$30+($D49*F15)*D31) =$E49*$D$34 =($F$18)/($E56+$F56)

=($C50*$D$30+($D50 G15)*D31) =$E50*$D$34 =($G$18)/($H56+$I56)

=($I49*$D$30+($J49*L15)*D31) =$K49*$D$34 =($L$18)/($M56+$N56)

=($I50*$D$30+($J50*M15)*D31) =$K50 D34 =(M18)/($P56 $Q56)

Table B 1 (continued)

				saumes that the top	cm pl soil are located on the surface				
Pu-239			78E-02	48E-06	and there is no contribution from soil below this depth				
					Soil Depth	Soil Density			
Pu-240			20E 02	54E-06	(cm)	(pCi/g)	=I40*]40		
U-234			7E-02	2E-06			84	20E-05	
U-235			90E+0	75E-03					
U-238		01	E+00	80E-05					
Am-24			99	75E-04					
							DFa(rem g/pCi/yr)=DF		
	Thorium				(mrem*sqm/uCi/yr)	uCi/1E6pCi*d(cm)*p(g/cc)	1E4sqcm/sqm	rem/1e3	
	Progeny		+C4	D39*0 000085*			mrem		

Dose factors base on values in DOE/EH-0070 for areal contamination

ES ENGINEERING SCIENC NC

Client RMRS Job No 726922 Sheet 1 of 4
Subject VOLUME CALCULATION - OU2 By DEWEESE Date 7/28/95
SURFACE SOIL IM/IRA Checked P.A. Noon Rev 7/28/95

PURPOSE CALCULATE THE VOLUME OF SURFACE SOIL REQUIRED TO BE EXCAVATED FOR VARIOUS ANALYSES IN THE ANALYSIS OF ALTERNATIVES

BASIS SURFACE SOIL SAMPLING WAS CONDUCTED DURING THE RFI/RI AT 2.5 AND 10 ACRE PLOTS. HUMAN HEALTH RISK FROM SURFICIAL CONTAMINATION WAS ESTABLISHED IN THE BRA THE VOLUME ESTIMATES ARE BASED ON THE RFI/RI RESULTS, BRA RESULTS, AND BRA RISK ASSESSMENT METHODOLOGIES SEE ATTACHED SHEET FOR EXCAVATED AREA DETERMINATIONS

ASSUMPTIONS AND CONSIDERATIONS THE MAJORITY OF SURFICIAL CONTAMINATION IS CONFINED TO THE UPPER 15 CM OF SOIL OUTSIDE THE 903 PAD AND LIP AREA THE 903 PAD WAS COVERERED WITH 20 CM OF CLEAN FILL THAT HAS BEEN SUBSEQUENTLY CONTAMINATED THE 20 CM OF NATURAL SOIL BENEATH THE FILL CONTAINS THE MAJORITY OF THE CONTAMINATION BOTH BENEATH THE PAD AND LIP AREA THEREFORE, THE FOLLOWING DEPTHS TO BE EXCAVATED, AS REQUIRED, ARE

903 PAD: ASPHALT PLUS 40 CM BENEATH ASPHALT
903 LIP AREA 20 CM
OTHER AREAS 15 CM (15 cm

THESE VALUES WILL BE USED TO DETERMINE COMPARATIVE VOLUMES FOR THE THREE CASES BECAUSE THIS IS A COMPARATIVE ANALYSIS AND BECAUSE EXACT VOLUME ESTIMATES CANNOT BE DETERMINED, ESTIMATES FOR THE AREAL EXTENT OF CONTAMINATION ARE USED

FOR EACH OF THE CASES THE 903 PAD AND LIP AREA WILL BE EXCAVATED TO PREVENT EROSION OF THE SOILS VIA WIND AND SURFACE WATER.

THE AREAS TO BE EXCAVATED COULD INCLUDE

- THE 903 PAD - IHSS 112
- THE 903 PAD LIP AREA - IHSS 183, AND INCLUDES THE SURFACE SOILS FROM TRENCH T-2, T903A, REACTIVE METAL DESTRUCTION SITE
- SURFACE SOIL PLOTS 29, 34, 35 AND 46 NOT INCLUDED ABOVE
- PLOT 46

CALCULATE VOLUMES

903 PAD THE PAD CONSISTS OF AN ASPHALTIC LAYER ABOVE APPROX 20 CM OF FILL OVER APPROX 20 CM OF CONTAMINATED SOIL. ASSUME A 3-INCH ASPHALTIC LAYER. THE VOLUME TO BE EXCAVATED IS

ASPHALT LAYER + 20 cm FILL + 20 cm SOIL

$$\text{ASPHALT LAYER VOLUME} = (3\,in)\left(\frac{1\,ft}{12\,in}\right)(3.4\,acre)\left(\frac{43560\,ft^2}{acre}\right)$$

$$= 37{,}026\,ft^3 = \boxed{1370\,yd^3}$$

$$\text{FILL VOLUME = OR SOIL VOLUME} \quad (20\,cm)\left(\frac{1\,in}{2.54\,cm}\right)\left(\frac{1\,ft}{12\,in}\right)(3.4\,acre)\left(\frac{43560\,ft^2}{acre}\right)$$

$$= 97{,}181\,ft^3 = \boxed{3600\,yd^3}$$

Total Volume = (Volume of Pad) + (Volume of fill) + (Volume of Contaminated Soil)

~~TOTAL~~ VOLUME = $1370 - 3600 + 3600 = \boxed{8570\,yd^3}$

PARSONS ENGINEERING SCIENCE, INC.

Client _ ' Y	Job No 721118	Sheet 1 of 1
Subject 2 Em/EIA - CONTAMNAIED	By EF Kr, I, JR	Date 23A - 95
SURFACE SOIL VOLUME ESTIMATES	Checked SR HUGHES	Rev 2

PURPOSE RECALCULATE VOLUMES PER CHANGES IN DOSE EQUIVALENT

EXCAVATION DEPTH 903 PAD 40 CM
903 LIP 20 CM
BUFFER ZONE 15 CM

NEW DATA (pCi/g)

	15 mrem		100 mrem	
	Pu 239	Am 241	Pu 239	Am 241
OFFICE WORKER	1,600	140	11,000	940
OPEN SPACE	16000	1400	110000	9600

ATTACHMENTS 1 AND 2 DISPLAY THE AREAL EXTENT OF SOILS TO BE REMOVED. NO Pu-239 EXCEEDENCES WERE IDENTIFIED. Approximately 31 Acres of office worker soils exceeded 15 mrem Am-241 levels. No exceedences were IDENTIFIED FOR 100 mrem Am-241 levels.

Total volume of soil to be removed from 903 PAD (cub YARDS) =

$$\left(31 \text{ Acres}\right)\left(\frac{43560 \text{ ft}^2}{1 \text{ acre}}\right)\left(20 \text{ cm}\right)\left(\frac{1 \text{ in}}{2.54 \text{ cm}}\right)\left(\frac{1 \text{ FT}}{12 \text{ in}}\right)\left(\frac{1 \text{ CY}}{27 \text{ ft}^3}\right) = \underline{\underline{3280 \text{ CY}}}$$

Seepage areas commonly appear to be moist or wet even though precipitation has not recently occurred These areas may or may not be marked by the presence of phreatophytes (plant species with roots that extend to the water table) The seeps are not normally point sources of overland flow and flow rates have not been estimated Visual observations suggest that most of the seepage currently evaporates or transpires

A 5 SITE AND LOCAL SOILS

Three types of soil have been described by the Soil Conservation Service (SCS) (1983) at the RFETS These soil types are designated as the following the Flatiron Series located on the Rocky Flats Alluvium the Nederland Series commonly located on the upper slopes flanking the Rocky Flats Alluvium and the Denver Kutch Midway Series located on slopes flanking the Nederland soils All of these soil series have been identified in the OU 2 area (SCS 1983) Figure A 10 presents a diagram of the various soils located within and around the RFETS

The Flatiron Series is a cobbly sandy loam that exhibits a slow infiltration rate and is located on slopes of 0 to 3 percent The Denver Kutch Midway Series is a clay loam also exhibiting a slow infiltration rate and develops on the Arapahoe Formation claystones where slopes range from 9 to 25 percent The Nederland Series develops adjacent to the Flatiron Series along the periphery of the Rocky Flats Alluvium where slopes range from 15 to 50 percent The Nederland Series soil exhibits a moderate infiltration rate All three soil types are partially obscured by fill materials gravel or buildings and other structures

A 6 REGIONAL AND LOCAL GEOLOGY

Significant work has been conducted recently to further characterize the geology at the RFETS A Geologic Characterization Report for the entire RFETS (EG&G 1991c) was prepared based on a comprehensive literature search and describes previously obtained core samples reprocesses previously obtained seismic data and analyzes select samples for grain size distribution A summary of the results of this study as they pertain to OU 2 is presented in the following sections

A 6 1 REGIONAL SETTING

The current structural setting of the central Rocky Mountain region is dominated by the subsidence of large basins and the rise of extensive uplifts such as the Denver Basin and Front Range For at least the second time the Front Range area has risen from below sea level to several thousand feet above sea level This tectonic event occurred during the Laramide Orogeny approximately 70 to 65 million years ago Concurrently the adjacent Denver Basin began and continued to subside to its current structural relief of at least 16 000 feet measured from the basin bottom onto the flank of the Front Range a distance of only a few miles

The Laramie Formation is the youngest pre Laramide Orogeny sediment package It is interpreted as a coastal plain deposit and records sedimentation prior to the uplift of the Front Range and subsidence of the Denver Basin The Laramie Formation consists of alternating yellowish gray sandstones varicolored kaolinitic claystones and siltstones with subbituminous coal beds in the upper part Laramide sediments which lie above the Laramie Formation comprise the Arapahoe and Denver Formations The Arapahoe Formation exposed along the Front Range west of Denver consists of a lower cross bedded conglomeratic sandstone sequence and an upper sequence of dark gray claystones and mudstones with thin layers of siltstone and sandstone The lower conglomeratic sandstone sequence is not ubiquitous and is generally not present at the RFETS The Arapahoe Formation lies unconformably upon the Laramie Formation and is thought to have been deposited in braided stream and channel margin environments

Structurally the RFETS is located on the western flank of the Denver Basin approximately 4 miles east of steeply dipping strata on the eastern flank of the Front Range West of the RFETS older sedimentary formations and the Laramie Formation claystones dip approximately 50 degrees to the east Beneath the RFETS bedrock flattens to a dip of approximately 3 degrees

The RFETS is located on a broad undulating eastward sloping pediment surface along the western edge of the Denver Basin Geologic units beneath the RFETS consist of unconsolidated surficial units including the Rocky Flats Alluvium younger terrace alluvium (Verdos Slocum and Louviers Alluvia) valley fill alluvium and colluvium (Figure A 11) These unconsolidated surficial deposits are unconformably underlain by approximately 10 000 feet of Pennsylvanian to Late Cretaceous sedimentary rocks that have been locally folded and faulted as shown in Figure A 12 Figure A 13 presents a generalized stratigraphic section of the Denver Basin bedrock formations Figure A 14 shows a stratigraphic section of the RFETS

A 6 2 OPERABLE UNIT 2 AREA GEOLOGY

Surficial Geology

Surficial geologic units within OU 2 consist of alluvial hillslope and man made deposits Alluvial deposits include the Pleistocene aged Rocky Flats Alluvium younger terrace alluvia and various Holocene aged valley fill alluvia Hillslope deposits consist of Holocene aged colluvium and landslide slumps Man made deposits are artificial fills debris dumps and areas of disturbed surficial soil A brief summary of the surficial deposits is presented below

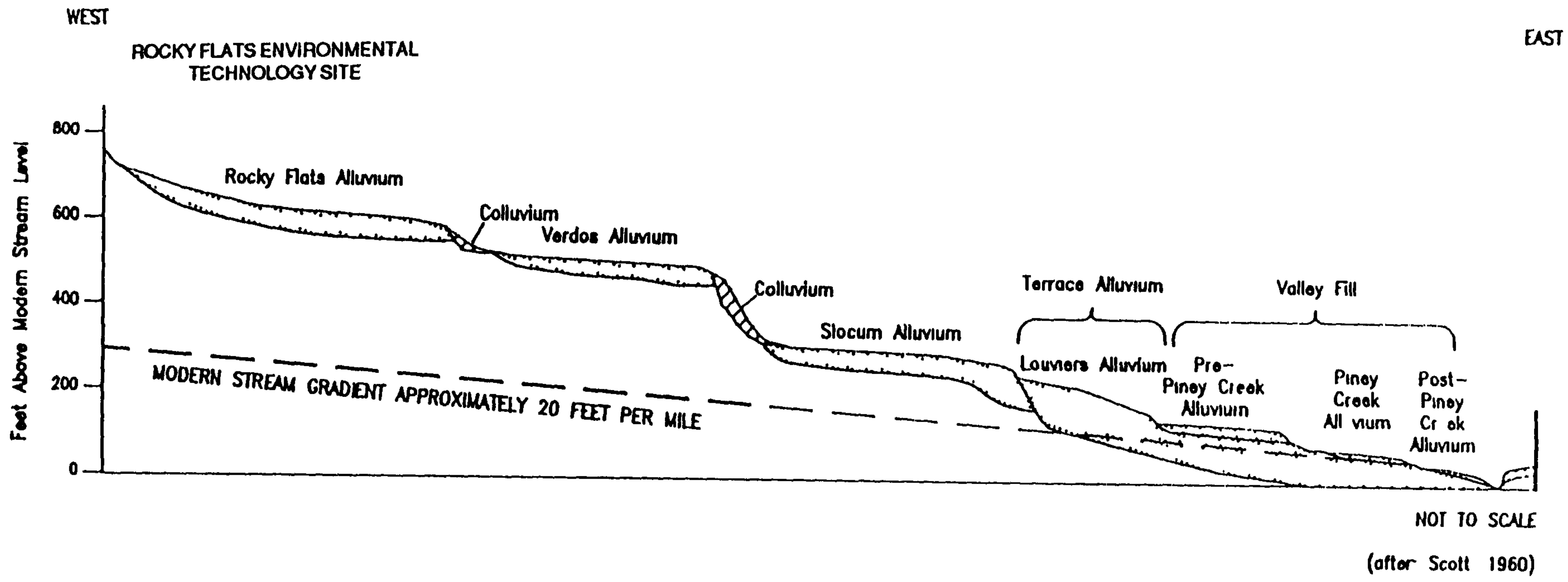
The Rocky Flats Alluvium is the topographically highest and oldest alluvial deposit at RFETS The Rocky Flats Alluvium within OU 2 caps the pediment surface between South Walnut and Woman Creeks The pediment is completely truncated to the north east, and south by these modern drainages The Rocky Flats Alluvium within the OU 2 area consists predominantly of beds and lenses of poorly to moderately sorted gravels and sands A few lenses of clay and silt also occur

Hillside deposits within the OU 2 area include several alluvial terrace deposits valley fill alluvium colluvium and landslide slumps Slump features belong to two categories 1) areas along the hillsides which exhibit evidence of mass movement of surficial soil and possibly bedrock materials along relatively distinct ruptures or glide surfaces and 2) areas of hummocky topography reflecting downslope creep of surficial soils but no observable rupture surface

Man made deposits within the OU 2 area have been identified using information from historical reports air photography and geologic field mapping Three general categories of man made deposits have been identified soil and debris dumps disturbed ground and artificial fill

Bedrock Geology

Bedrock geologic units within the OU 2 area consist of claystones siltstones and sandstones The No 1 Sandstone is considered the basal part of the Arapahoe Formation All lower bedrock units are considered to be a part of the upper Laramie Formation (DOE 1993)



Source EG&G 1991 Draft Final Geologic Characterization Report for the RFP"

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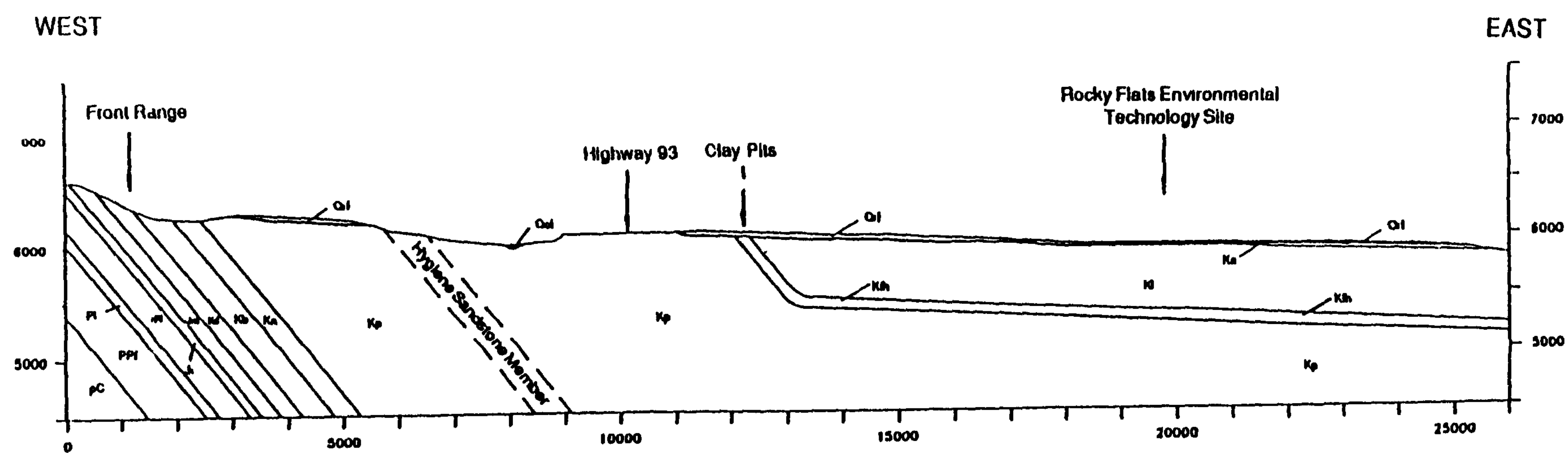
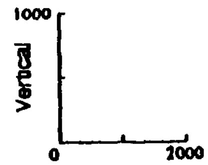
Fig e A 11

Ope able U it No 2
Erosional Surface and Alluvial Deposits East of the Front Range Colorado



EXPLANATION

Qrf = Quaternary Rocky Flats Alluvium
Qvf = Quaternary Valley Fill Alluvium
Ka = Cretaceous Arapahoe Formation
Kl = Cretaceous Laramie Formation
Kfh = Cretaceous Fox Hills Sandstone
Kp = Cretaceous Pierre Shale
Kn = Cretaceous Niobrara Formation
Kb = Cretaceous Benton Shale
Kd = Cretaceous Dakota Group
Jm = Jurassic Morrison Formation
Jrc = Jurassic Ralston Creek Formation
TrPl = Perma Triassic Lykins Formation
Ply = Permian Lyons Sandstone
PPf = Pennsylvanian Permian Fountain Formation
pC = Precambrian



Horizontal
Scale in Feet
2x Vertical Exaggeration

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Fig re A 12

Ope able U it No 2
Ge eralized West East Cross Section
Front Range to the Rocky Flats Environmental Technology Site

Modified from Hurr 1976

d85 1 h

AGE	FORMATION	Thickness (ft)	SUMMARY DESCRIPTION
TERTIARY	Green Mountain	600	Boulder conglomerate with occasional thin siltstone lense
TERTIARY	Denver	870	Yellowish brown to grayish-olive fluvial tuffaceous claystone siltstone and sandstone interbedded with conglomerate and olive-gray mudflows
UPPER CRETACEOUS	Arapahoe	250	Yellowish-gray to yellowish-brown sandstone siltstone and claystone discontinuous conglomerate at base
UPPER CRETACEOUS	Laramie	700	Gray fine-to-medium-grained sandstone and silty clays thin coal beds lower part
UPPER CRETACEOUS	Fox Hills	60	Tan fine-to-medium-grained sandstone and sandy shale
UPPER CRETACEOUS	Pierre	± 8000	Dark gray silty shale and few thin silty sandstones
UPPER CRETACEOUS	Niobrara	350	Dark gray very calcareous shale Foraminifers abundant (Smoky Hills Member) Light gray dense fossiliferous limestone (Fort Hays Member)
UPPER CRETACEOUS	Benton	420	Brown sandy fossiliferous limestone Dark gray shale with bentonite streaks thin limestones in middle part, few cone-in-cone concretions in lower part Dark gray brittle silty shale (Mowry)
LOWER CRETACEOUS	Dakota Group: So Platte	270	Light gray fine-to-medium-grained sandstone several dark gray shales in middle part
LOWER CRETACEOUS	Dakota Group: Lytle	100	Light gray fine-to-coarse-grained locally conglomeratic sandstone frequent red and green siltstone interbeds
Jurassic	Morrison	36	Gray to greenish-gray to red shale and siltstone thin limestones in middle part, lenticular sandstones in upper and lower part
Jurassic	Ralston Creek	[illegible]	Light tan siltstone and light red silty shale gypsiferous sandstone at base and locally conglomeratic
TRIASSIC	Lykins	400	Red siltstone with two laminated limestones in lower part
PERMIAN	Lyons	120	Grayish-white fine-to-medium-grained cross-bedded sandstone conglomeratic lenses frequent
PENNSYLVANIAN	Fountain	1000	Red fine-to-coarse-grained sandstone and conglomerate arkosic thin lenticular red siltstones frequent throughout
PRECAMBRIAN			Gneiss schist and small granitic intrusions

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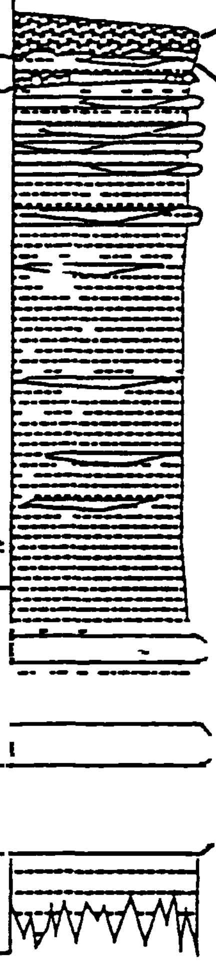
Figure A 13

Operable Unit No 2
Generalized Stratigraphic Section of the Denver Basin Bedrock

Source EG&G 1991 Draft Final Geologic Characterization Report for the RFP"

Age	Formation	Thickness (feet)
Quaternary	Rocky Flats Alluvium/ Colluvium	0-100
Cretaceous	Arapahoe Fm.	0-60
	Laramie Formation	600-800 upper interval: 300-500 lower interval 300
	Fox Hills Sandstone	90-140
	Pierre Shale and older units	



Clayey Sandy Gravels reddish brown to yellowish brown matrix grayish orange to dark gray poorly sorted angular to subrounded cobbles coarse gravels coarse sands and gravelly clays varying amounts of caliche

Claystones Silty Claystones and Sandstones light to medium olive-gray with some dark olive black claystone silty claystone and fine-grained sandstone weathers yellowish orange to yellowish brown a mappable light to olive gray medium- to coarse grained frosted sandstone to conglomeratic sandstone occurs locally at the base (Arapahoe marker bed)

Claystones Silty Claystones Clayey Sandstones and Sandstones kaolinitic light to medium gray claystone and silty claystone and some dark gray to black carbonaceous claystone thin (2') coal beds and thin discontinuous very fine to medium-grained moderately sorted sandstone intervals

Sandstones Claystones and Coals light to medium gray fine to coarse-grained moderately to well sorted silty immature quartzose sandstone with numerous claystones and subbituminous coal beds and seams that range from 2 to 8 thick

Sandstones grayish orange to light gray calcareous fine-grained subrounded glauconitic friable sandstone

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Figure A 14

Operable Unit No 2
Generalized Stratigraphic Section of the Rocky Flats Environmental Technology Site

Source EG&G 1991 Draft Final Geologic Characterization Report for the RFP

Subsurface investigations have shown that the Arapahoe Formation No 1 Sandstone (No 1 Sandstone) is a distinct bedrock unit separate in geologic characteristics from the underlying Laramie Formation Most of the No 1 Sandstones are predominantly fine to medium grained and represent deposition in low to moderate flow regimes The No 1 Sandstone is the stratigraphically highest sandstone encountered within the OU 2 area It is stratigraphically located from 0 to 20 feet below the overlying surficial deposits The sandstone directly underlies the Rocky Flats Alluvium along a medial paleoscour beneath OU 2 Prior to deposition of the Rocky Flats Alluvium erosion of the claystone/siltsone material in this area created the paleoscour The resulting subcrop area beneath the Rocky Flats Alluvium is an important feature in that it allows vertical groundwater flow to the No 1 Sandstone from the overlying alluvial units

The Laramie Formation is a fresh to brackish water non marine deposit Lithologic logging of the upper Laramie Formation suggests that in this area it is largely composed of claystone with lenses of fine grained sandstone The most common upper Laramie Formation lithologies encountered in boreholes within the OU 2 area are claystones and silty claystones The upper Laramie Formation sandstone or siltstone interbeds are approximately 10 feet thick except where interbeds are stacked on top of each other Where sandstone interbeds are stacked a thicker sandstone sequence results The sandstone interbeds are commonly separated by thin siltstone or claystone layers

A 7 REGIONAL AND LOCAL HYDROGEOLOGY

This section describes the hydrogeology of the RFETS and specifically the OU 2 study area including the unconfined and confined ground water systems present at the RFETS Unconfined ground water flow occurs in unconsolidated geologic materials (Rocky Flats alluvium valley fill alluvium and colluvium) and in subcropping bedrock (Arapahoe Formation) sandstones Since unconfined flow occurs in more than one stratigraphic unit the term Upper Hydrostratigraphic Unit (Upper HSU) is used to reference strata in which unconfined flow occurs The Upper HSU also includes some saturated subcropping claystones that are weathered and fractured Ground water flow in the lower (Laramie Formation) sandstone units and in saturated zones of deeper (Laramie Formation) claystones with sufficient hydraulic conductivity occurs under confined conditions This deeper confined aquifer system is referred to as the Lower Hydrostratigraphic Unit (Lower HSU) to avoid confusion with the upper unconfined unit.

A 7 1 REGIONAL SETTING

The RFETS is situated in a regional ground water recharge area Regionally ground water flows from west to east in the Upper HSU and along the Arapahoe Formation alluvium contact where the subcropping Arapahoe Formation consists of claystones with local flow direction variations along drainages and bedrock topographic highs Arapahoe Formation claystones have a low hydraulic conductivity (K) on the order of 10^{-7} cm/sec (approximately 0 1 feet per year (ft/yr)) effectively constraining much of the surficial recharge flow to the Upper HSU (see Parts II & III) Surficial recharge flow is further confined to the Upper HSU by the low K exhibited by upper Laramie Formation claystones which underlie the Arapahoe Formation sandstones of the Upper HSU

The Upper HSU is characterized by rapid changes in water table elevation in response to short term precipitation events This is evident from the water level measurements taken from the ground water monitoring wells before and after precipitation events Water levels in the Upper HSU are generally highest in spring and early summer and lowest during the winter months In the western part of the RFETS where the thickness of the surficial material is greatest the depth to the water table (top of Upper HSU) is about 50 to 70 feet bgs Although the water table depth is variable it becomes shallower from west to east as the surficial material thins Seeps are common in the stream drainages at the base of the Rocky Flats Alluvium or where Arapahoe Formation sandstones are exposed

The lower sandstone unit of the Laramie Formation and the underlying Fox Hills Sandstone comprise an important aquifer in the Denver Basin known as the Laramie/Fox Hills aquifer referred to herein as the Lower HSU The thickness of the aquifer near the center of the Denver Basin ranges from 200 to 300 feet These formations outcrop west of the RFETS along the Front Range and dip between 45 and 50 degrees to the east The dip of these formations decreases to less than 2 degrees beneath the central part of the RFETS Ground water recharge to the Lower HSU occurs as precipitation and runoff infiltrates bedrock at the steeply dipping and eroded ends of the strata along the western limb of the monoclinal fold

A 7 2 OPERABLE UNIT 2 AREA HYDROGEOLOGY

Within OU 2 the UHSU is comprised of variably and seasonally saturated parts of the unconsolidated surficial deposits the No 1 Sandstone that is in hydraulic connection with the saturated surficial materials and weathered claystones of the Arapahoe and/or Laramie Formations Laramie Formation sandstones that subcrop beneath the No 1 Sandstone or saturated surficial soils also are considered part of the UHSU The unconsolidated surficial deposits consist of the Rockv Flats Alluvium colluvium valley fill alluvium and disturbed ground Groundwater is present in the UHSU under unconfined conditions except where parts of the No 1 Sandstone are overlain by claystone which results in both confined and unconfined conditions within the sandstone Figure A 15 presents a schematic cross section of the site hydrostratigraphy

The UHSU is located over the relatively flat divide of South Walnut Creek and Woman Creek and is truncated to the north east and south along these drainages The thickness and geometry of the UHSU geologic units are controlled by bedrock paleotopography specifically the north and south paleoridges that generally trend east northeast the medial paleoscour that lies between the two paleoridges other bedrock paleotopographic lows and steps that exist on the weathered bedrock paleotopographic surface and depositional channels of the sandstones included in the UHSU A bedrock paleotopographic map is provided in Figure A 16

Groundwater flow within the UHSU is complex because of variations in groundwater flow directions interactions between geologic units and variations in degree of saturation and saturated thickness Groundwater flow within the UHSU is strongly influenced by the bedrock paleotopography and the geometry and hydraulic characteristics of the unconsolidated deposits comprising the UHSU Groundwater within the UHSU generally is found within the area described as the medial paleoscour (Figure A 16) and generally flows towards the northeast In the area of Trench 2 immediately south of the drum storage site groundwater locally flows to the south during high water table conditions

The areal extent and saturated thickness of the UHSU within the medial paleoscour vary seasonally The north and south paleoridges restrict groundwater outflow from the alluvium to the north and south The medial paleoscour is erosionally truncated along the north facing hillslope of South Walnut Creek UHSU groundwater discharges from the No 1 Sandstone as seeps from this area.

Groundwater recharge to the UHSU within OU 2 occurs as direct infiltration of precipitation and by lateral and downward seepage from surface water features such as ditches Recharge to the No 1 Sandstone probably occurs from infiltration of precipitation and surface water through the overlying unsaturated surficial deposits vertical groundwater flow from the overlying saturated surficial deposits and inflow from the saturated sandstone units upgradient (west) of OU 2

A 8 ECOLOGY

The following sections describe vegetation aquatic life wildlife threatened or endangered species and sensitive environments at the RFETS and specifically OU 2

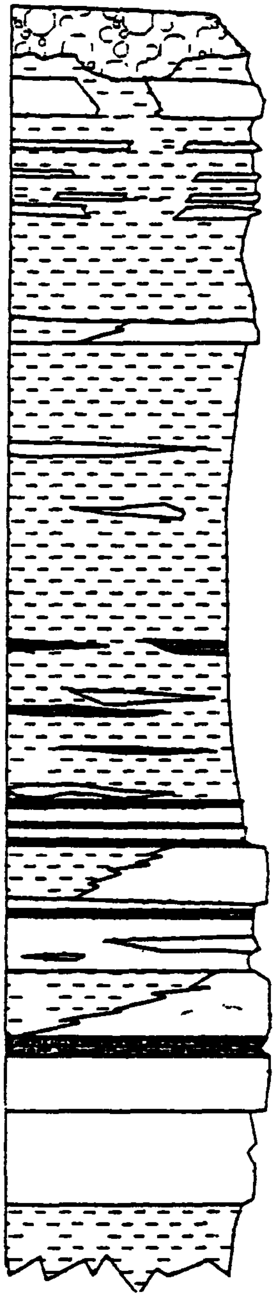
A 8 1 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE ECOLOGY

A variety of plant life is found at the RFETS The predominant vegetation found on the western portion of the site is disturbed mixed prairie a mixture of both short and mid length grasses The eastern portion of the RFETS is generally highly disturbed from overgrazing and short grasses are dominant Common grasses include smooth brome (*Bromus inermis*) crested wheatgrass (*Agropyron cristatum*) mountain muhly (*Muhlenbergia montana*) and western wheatgrass (*Agropyron smithii*) Sedges (*Carex nebraskensis*) and rushes (*Juncus arcticus*) are found in stream floodplains and wet valley bottoms Cottonwoods (*Populus sargentii*) baltic rush (*Juncus balticus*) and cattails (*Typha latifolia*) line many riparian areas Other species include salsify (*Tragopogon dubius*) kochia (*Kochia scoparia* and iranica) white sweet clover (*Melilotus alba*) Canada thistle (*Cirsium arvense*) and spike rush Since acquisition of the buffer zone property vegetative recovery has occurred as evidenced by the presence of disturbance sensitive species such as big bluestem (*Andropogon gerardii*) and side oats grama (*Bouteloua curtipendula*) Figure A 17 illustrates the location of upland habitats at the RFETS

Aquatic ecosystems present within the RFETS include perennial and intermittent streams and human made ditches canals ponds and reservoirs The principal components of the aquatic ecosystems are the periphyton photoplankton benthic macroinvertebrates amphibians and fish The types of aquatic communities and diversity of species in each of these components are dependent on the type of substrate water characteristics (such as depth and flow regime water quality and creek or pond morphology) water management practices and season Fish species are mostly absent in the intermittent streams but are abundant in the larger ponds and reservoirs (DOE 1992d)

Animal populations within the RFETS are representative of species typical of western prairie regions A chain link fence surrounding the industrial area effectively limits the habitat of the most common large mammal the mule deer (*Odocoileus hemionus*) to the buffer zone There are a number of small carnivores within the buffer zone such as the coyote (*Canis latrans*) red fox (*Vulpes vulpes*) striped skunk (*Mephitis mephitis*) long tailed weasel (*Mustela frenata*) and the feral cat. Small herbivores are common throughout the RFETS complex and buffer zone including the pocket gopher (*Thomomys sp*) white tailed jackrabbit

PERIOD	STRATIGRAPHY	LITHOLOGIC UNIT & APPROXIMATE THICKNESS	DESCRIPTION
QUATERNARY		ROCKY FLATS ALLUVIUM 0–45	CLAYEY SANDY GRAVELS– light brown to yellowish–orange grayish–orange to dark gray poorly sorted angular to subrounded cobbles coarse gravels coarse sands and gravelly clays varying amounts of caliche
CRETACEOUS		ARAPAHOE FORMATION 60 (?)	CLAYSTONE, SILTSTONES CLAYEY SANDSTONES SANDSTONE– l ght to medium ol ve–gray with some dark olive–black claystone and s lty claystone Weathered intervals may be yellowed and basal sand is often conglomeratic
		LARAMIE FORMATION (600–800) upper interval 300–500	CLAYSTONES SILTSTONES AND COAL– kaolinitic light to medium gray claystone and siltstone and some dark gray to black carbonaceous claystone thin (2) coals and thin discontinuous very fine–to–medium grained moderately sorted sandstone intervals
		LARAMIE FORMATION (600–800) lower nterval 300	SANDSTONES light to medium gray fine–to coarse–grained poorly–to moderately–sorted s lty mature quartzitic sandstone with numerous lenticular sub–b tum nous coal beds and seams that range from 2 thick in the upper lower interval to 8 thick at the base of the lower interval
		FOX HILLS SANDSTONE 80	SANDSTONES– grayish–orange to light gray calcareous fine–grained subrounded glauconitic feldspathic friable sandstone
		PIERRE SHALE & OLDER UNITS	



MODIFIED AFTER DOE 1992b

EXPLANATION

- ALLUVIUM
- FINE–GRAINED & COARSER SANDSTONE
- FINE GRAINED SANDSTONE
- SILTSTONE & CLAYSTONE
- COAL
- SILTY SANDSTONE

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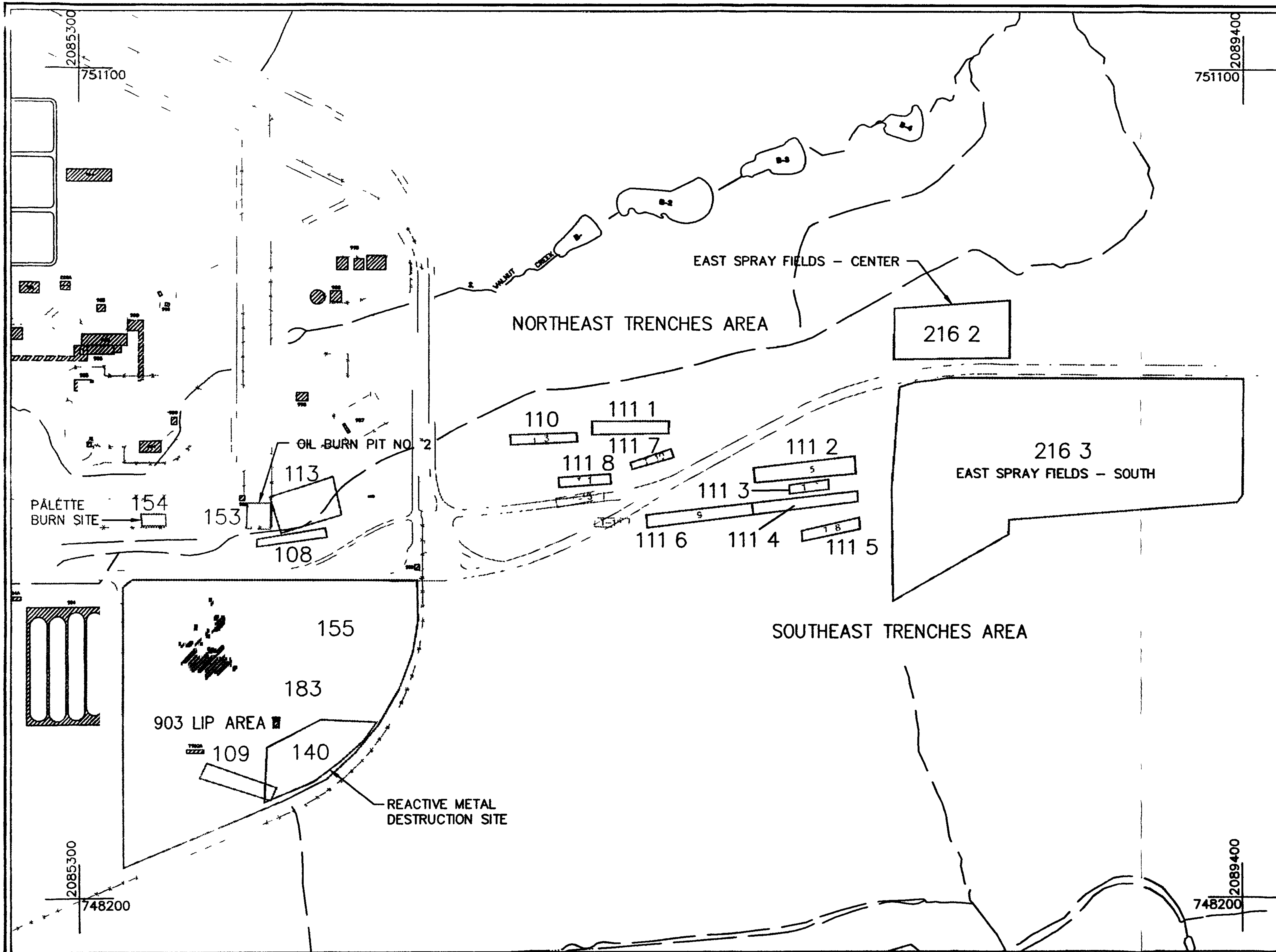
GOLDEN COLORADO

F gure A 15

Ope able Un t No 2
Local Stratigraph c Column of
the o 2 Area
Rocky Flats En i onmental Technology S te



LEGEND

- Streams
- Paved Roads
- Buildings
- Fence
- New IHSS Boundary
- 216 3 IHSS Identification Number

0 250 500 FEET

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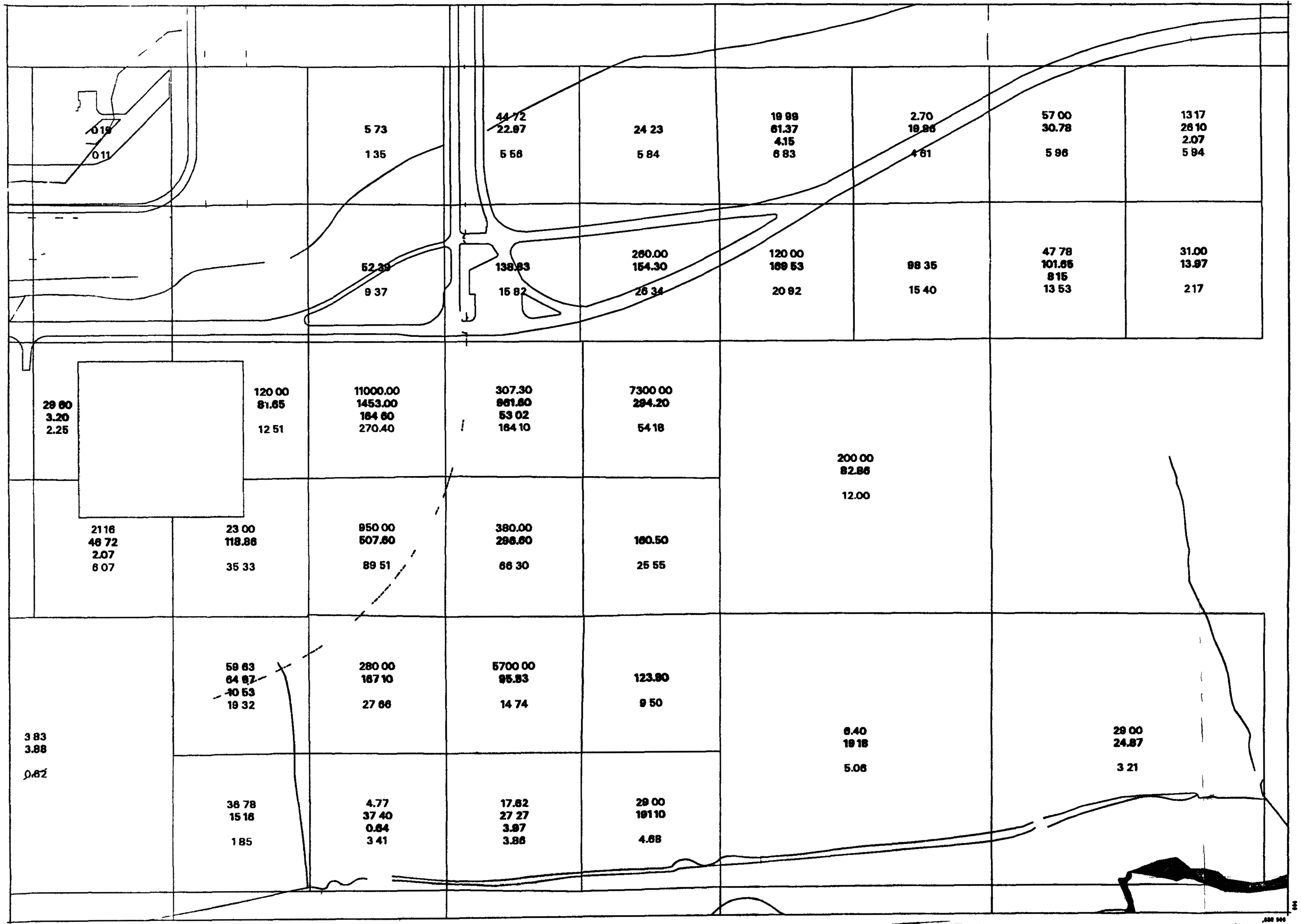
GOLDEN, COLORADO

Figure I. 2 2

Operable Unit No. 2
Interim Measure/ Interim Remedial Action
Map of IHSSs Within OU2

95DN1352 09/18/95 at 13 00

Rocky Flats Surface Soil Sampling Plot Locations Around the 903 Pad



EXPLANATION

- 903 Pad
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Paved roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. 1991.
Hydrology provided by USGS (date unknown)

1st Number	Pu 239 +240	RFP Result
2nd Number	Pu 239 240	CDH Result
3rd Number	Am 241	RFP Result
4th Number	Am 241	CDH Result

Scale 1:3000
1 inch represents 250 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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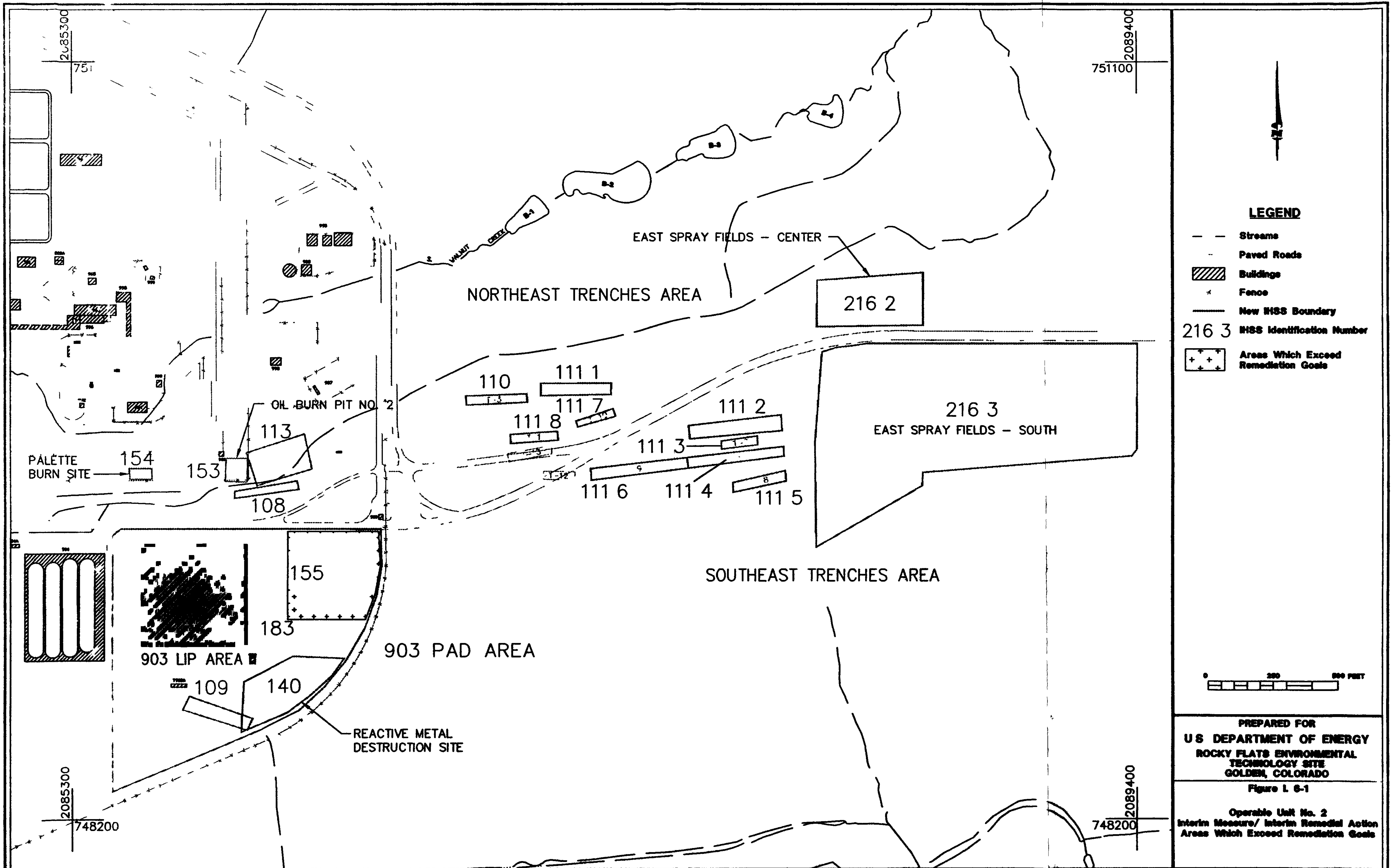
GOLDEN, COLORADO

Figure I 5-1

Operable Unit No. 2
Surface Soil
Sampling Locations

G \PM4\EG&G\RF11X17



95DN1353 09/18/95 at 14 00

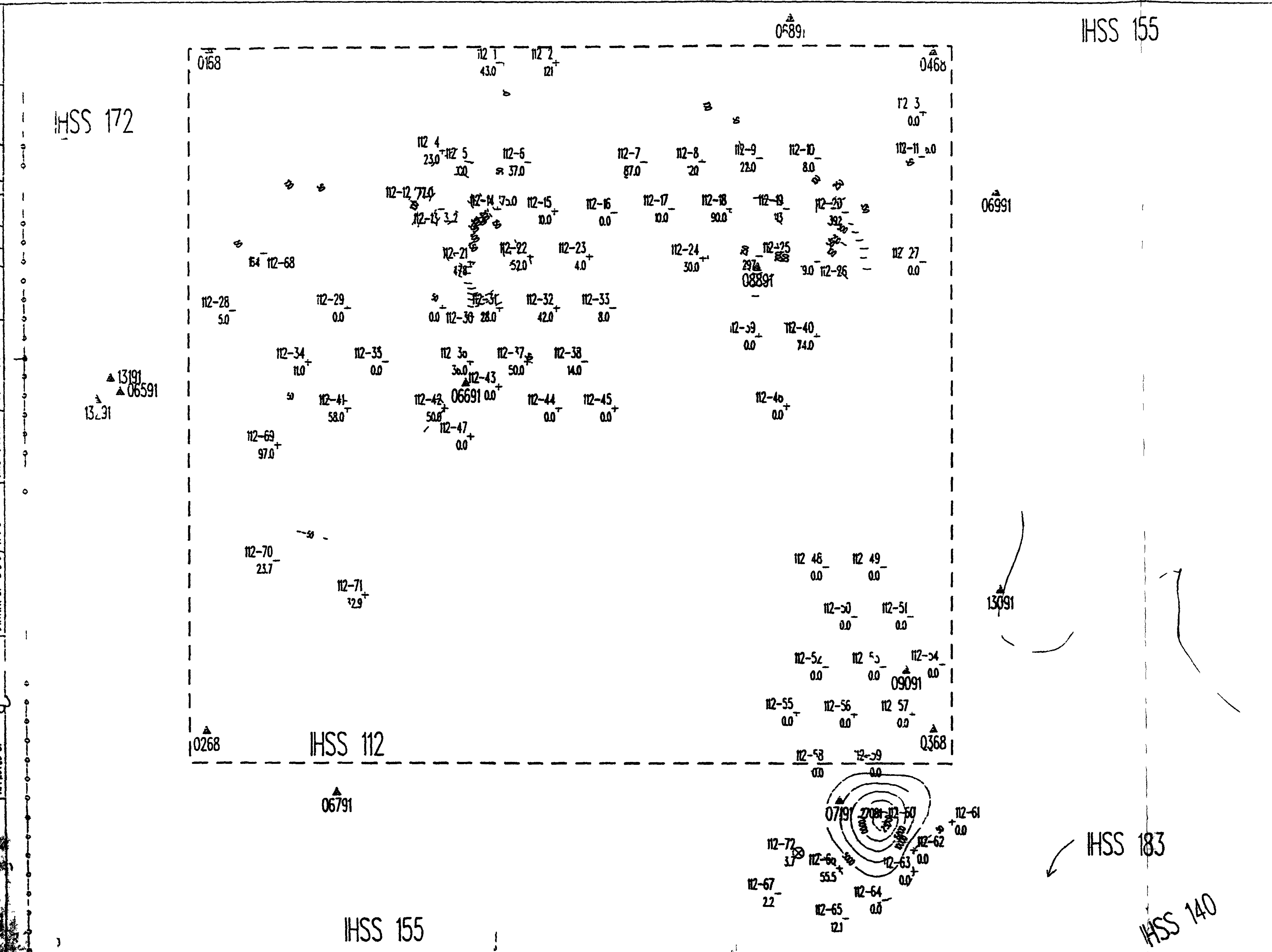


Figure II 5 3 1

Soil Vapor Survey Sampling Locations TOTAL VOCs (ug/L)

112-1 0.0 — 5 Foot Sample Depth

112-72 0.0 ⊗ — 10 Foot Sample Depth

03091 — Boreholes

Soil Vapor Survey Work Plan IHSS 112 Border

Adjacent IHSS Borders

Fence

CONTOUR INTERVAL

5000 ug/L

50 ug/L

NOTE Analyte values from the 10 foot depth were not used in the generation of the contours

NOTE THE CONTOURS HAVE BEEN COMPUTER GENERATED FROM A LIMITED NUMBER OF POINTS AND MAY NOT REPRESENT ACTUAL FIELD CONCENTRATIONS

25 0 25 50 FEET

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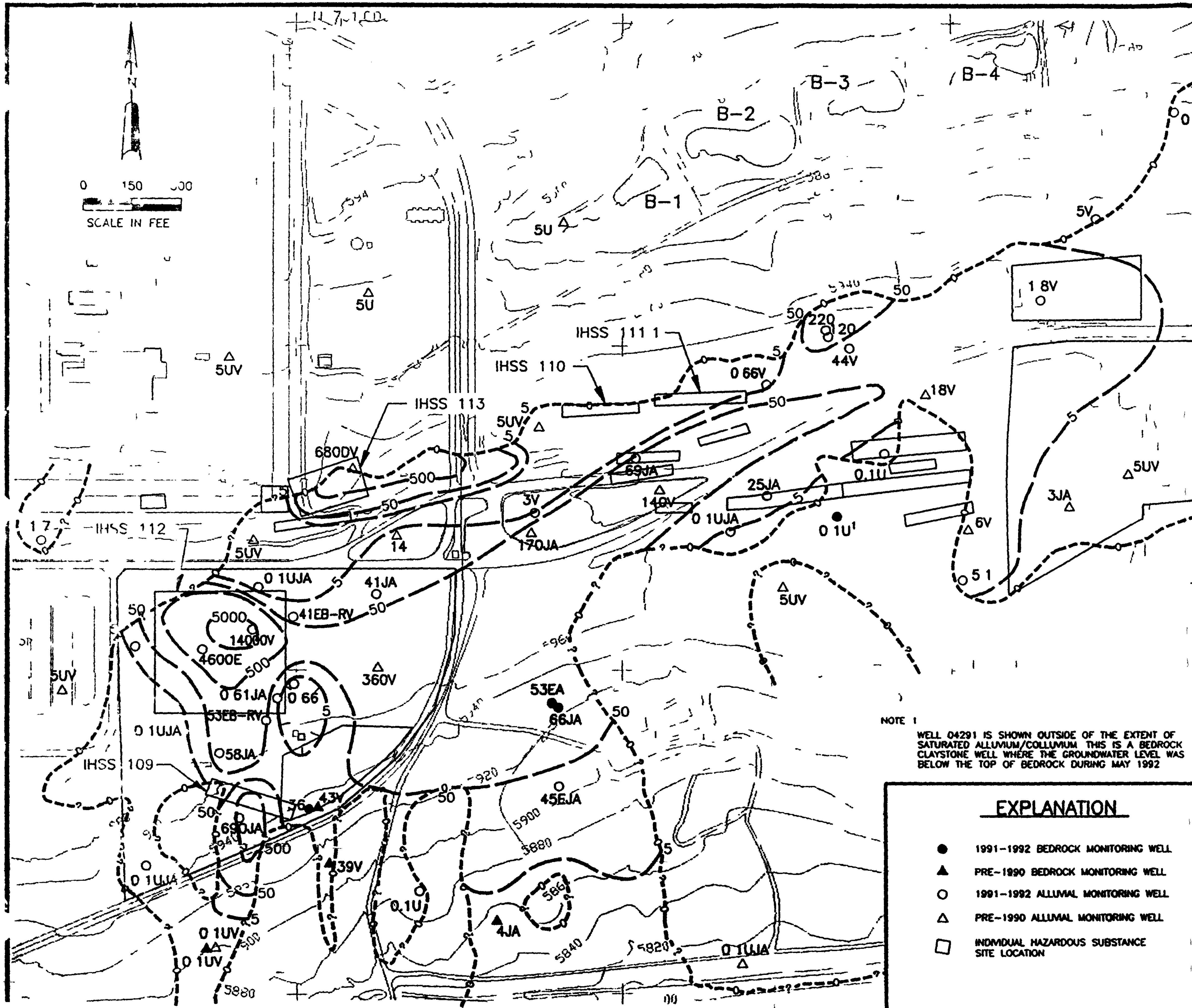
ROCKY FLATS PLANT
GOLDEN COLORADO

FIGURE C 6 IHSS 112 (903 PAD)
Total VOCs
ISOCONCENTRATION
CONTOUR MAP
AT 5 FOOT DEPTH

APPROVED BY	DRAWN BY DDJ/KJS	DATE February 11 1994	FILENAME /arc/data/soilvapor/ihss112/svs2352 aml	REVISION NO 2	



EXPLANATION

840V = CONCENTRATION (µg/l)

5 = APPROXIMATE LINE OF EQUAL CONCENTRATION (µg/l) (? WHERE EXTRAPOLATED)

= APPROXIMATE LATERAL EXTENT OF SATURATED ALLUVIUM/COLLUVIUM (? WHERE EXTRAPOLATED)

LABORATORY AND VALIDATION QUALIFIERS ARE PRESENTED ON FIGURE 4 2-1 SEE FIGURE 4 4-2 FOR WELL NUMBERS

NOTE 1

WELL 04291 IS SHOWN OUTSIDE OF THE EXTENT OF SATURATED ALLUVIUM/COLLUVIUM THIS IS A BEDROCK CLAYSTONE WELL WHERE THE GROUNDWATER LEVEL WAS BELOW THE TOP OF BEDROCK DURING MAY 1992

EXPLANATION

- ● 1991–1992 BEDROCK MONITORING WELL
- ▲ PRE–1990 BEDROCK MONITORING WELL
- ○ 1991–1992 ALLUVIAL MONITORING WELL
- △ PRE–1990 ALLUVIAL MONITORING WELL
- □ INDIVIDUAL HAZARDOUS SUBSTANCE SITE LOCATION

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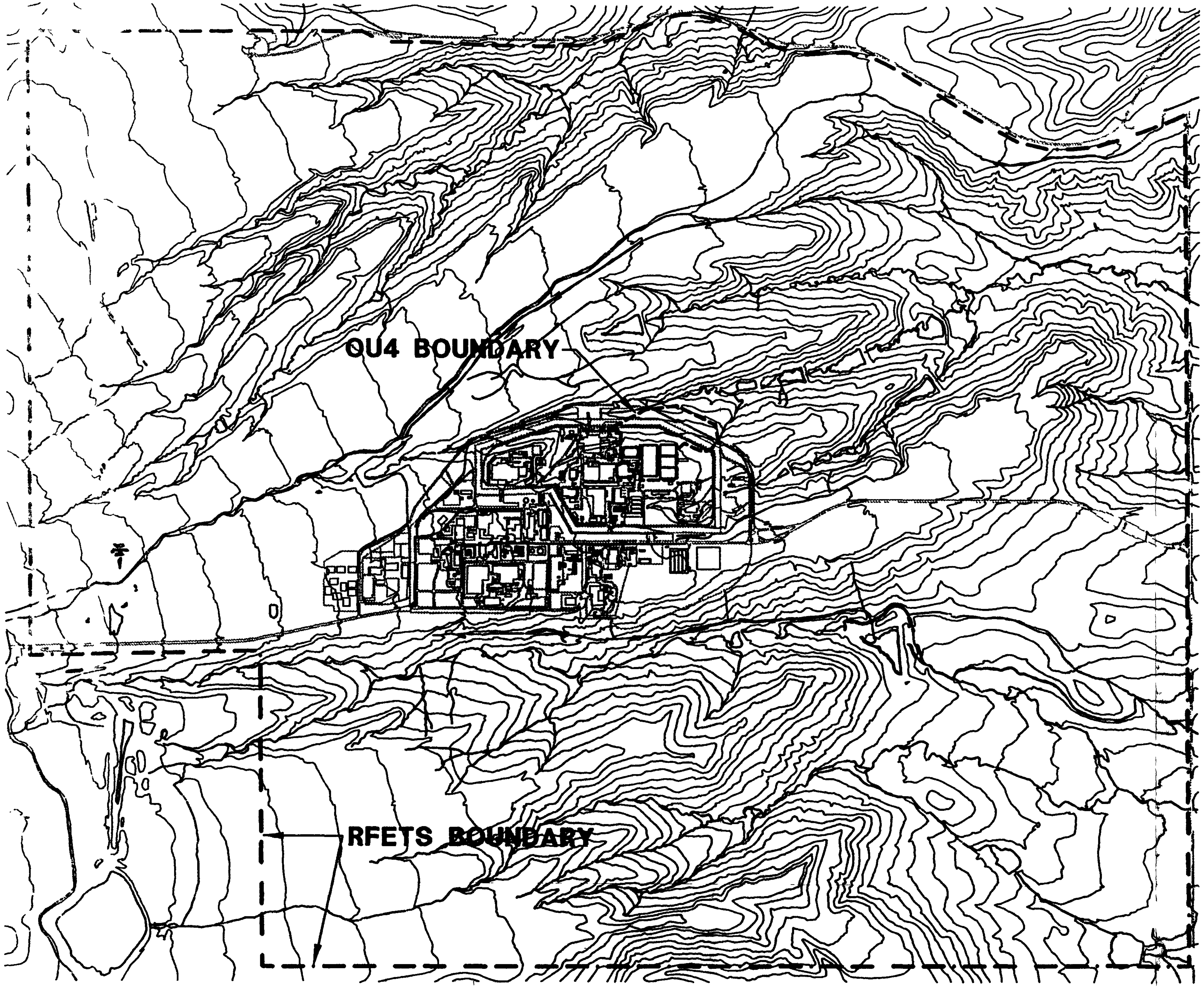
Golden Colorado

OPERABLE UNIT 2
PHASE II RFI/RI REPORT

TETRACHLOROTHENE
ISOCONCENTRATION MAP
FOR THE ALLUVIAL/COLLUVIAL
UHSU GROUNDWATER FLOW SYSTEM
SECOND QUARTER 1992

Figure II 5 3 2

APRIL 1995



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TECHNOLOGY SITE
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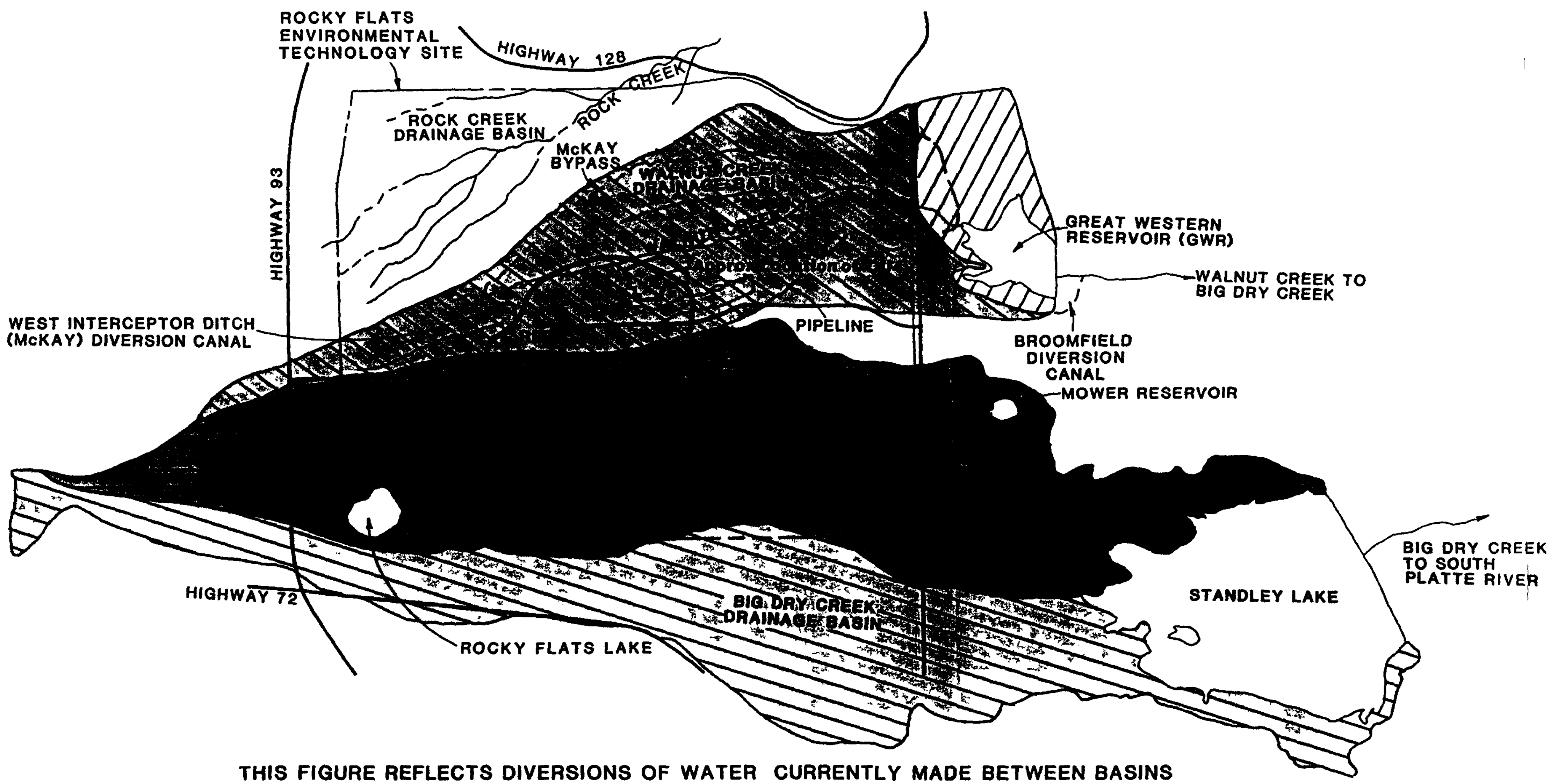
Figure A-4

Operable Unit No. 2
Topography in the Vicinity of the
Rocky Flats Environmental Technology Site



THIS FIGURE REFLECTS DIVERSIONS OF WATER CURRENTLY MADE BETWEEN BASINS

N

0

LEGEND

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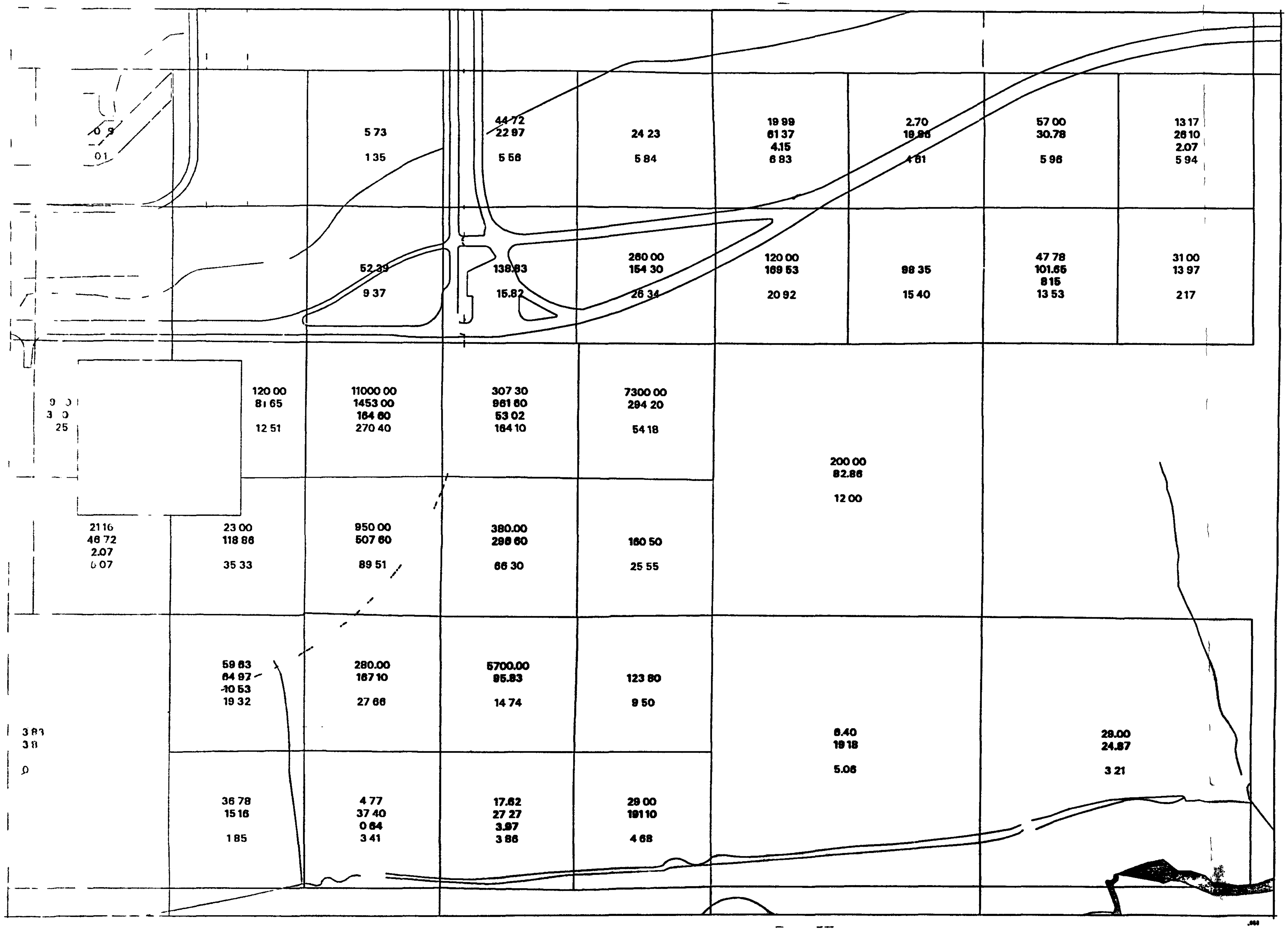
U S DE A?T MENT OF .NERGY
ROCKY FL T EN IRC NTAL
E HNOL GY SITE
C L EN C ORA O

F g re A-6

Op able t No 2
E onmental
T ch R

Source EG&G 1992. Environmental Restoration Technical Support Document

d11 17



Rocky Flats Surface Soil Sampling Plot Locations Around the 903 Pad

EXPLANATION

- 903 Pad
- Lak and pond
- St ams, dit hes, or h r d a g f at
- Fences
- Paved d

DATA SOURCE
Buildings, roads, and fences provided by Facilities Engr EG&G Rocky Flats, Inc. 89
Hydrology provided by USGS (date unknown)

1st Number	Pu 239 +240	RFP Result
2nd Number	Pu 239 +240	CDH Result
3rd Number	Am 241	RFP Result
4th Number	Am 241	CDH Result

Scale 1:2000
1 inch represents 250 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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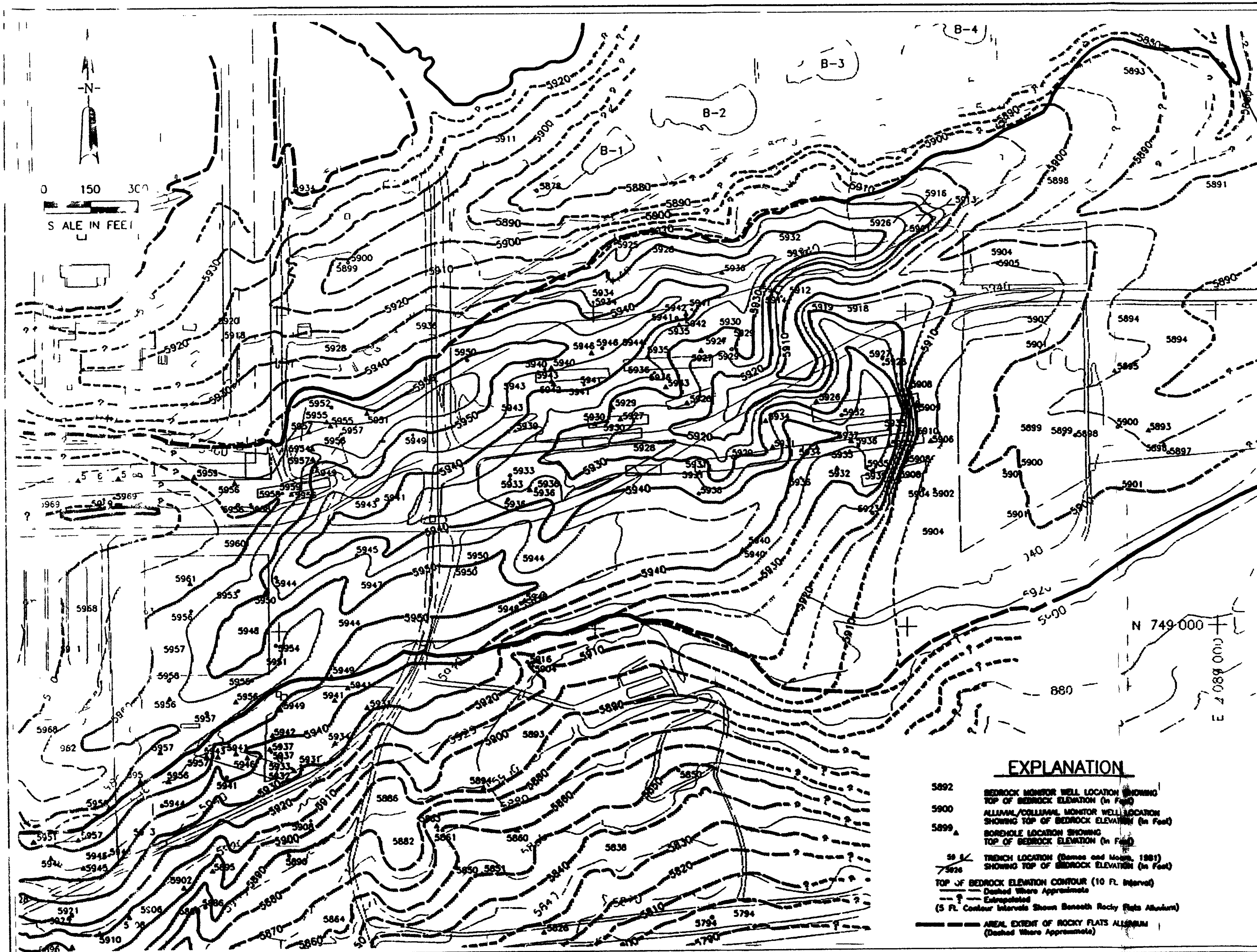
GOLDEN COLORADO

Operable Unit No 2
Surface Soil
Sampling Locations

PM4 EGAG RF X 7



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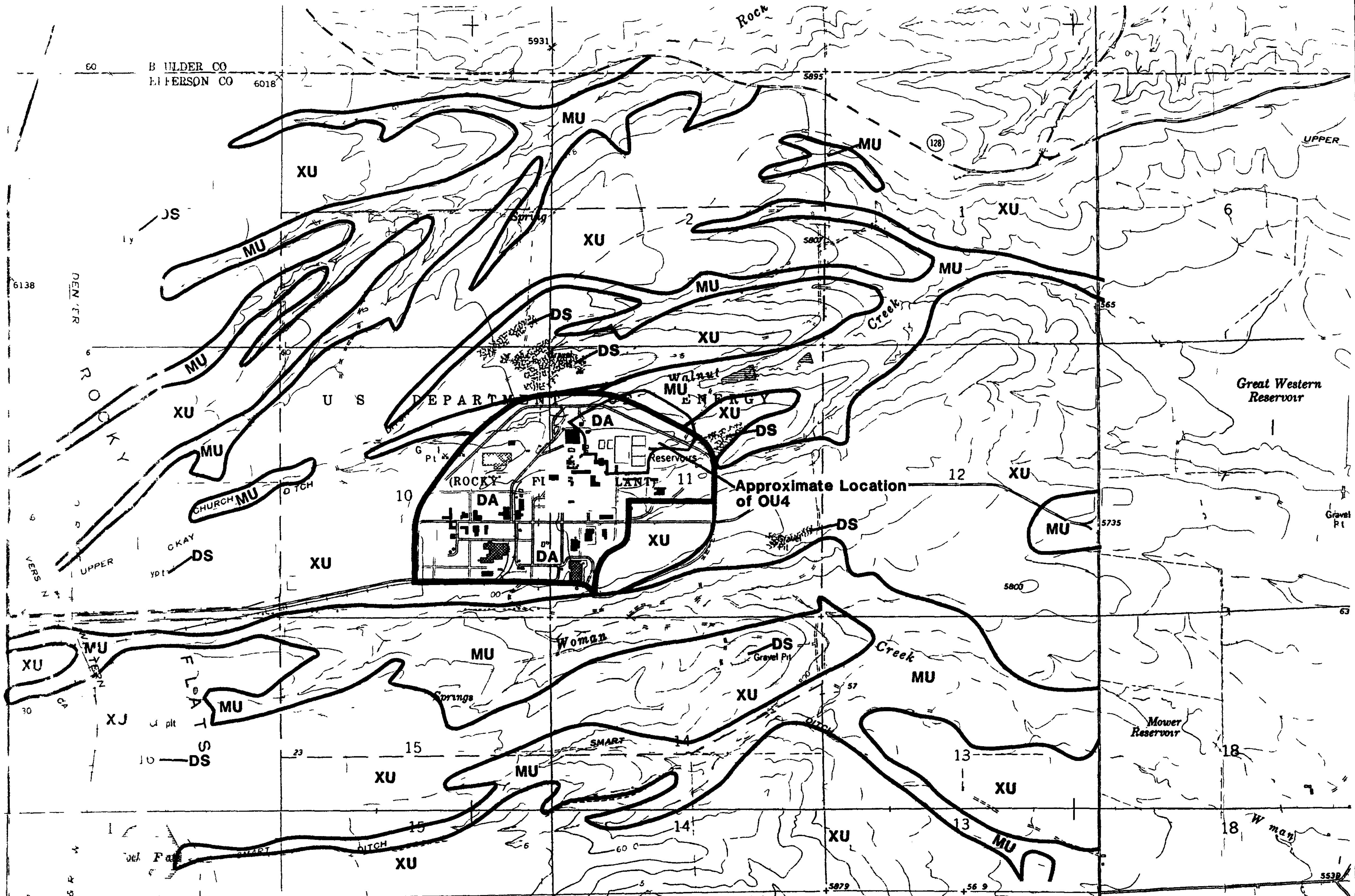
GOLDEN, COLORADO

Figure A 16

Operable Unit No. 2
Top of Bedrock Elevation
Beneath Alluvial/Colluvial Cover

\P.M G&G\RF11X17



Source ASI 1991 The SEPs ITS Ground Water Management Study

LEGEND

- **XU** Xeric Upland Habitats
- **MU** Mesic Upland Habitats
- **DS** Highly Disturbed Sites
- **DA** Developed Areas

0 2000 FEET

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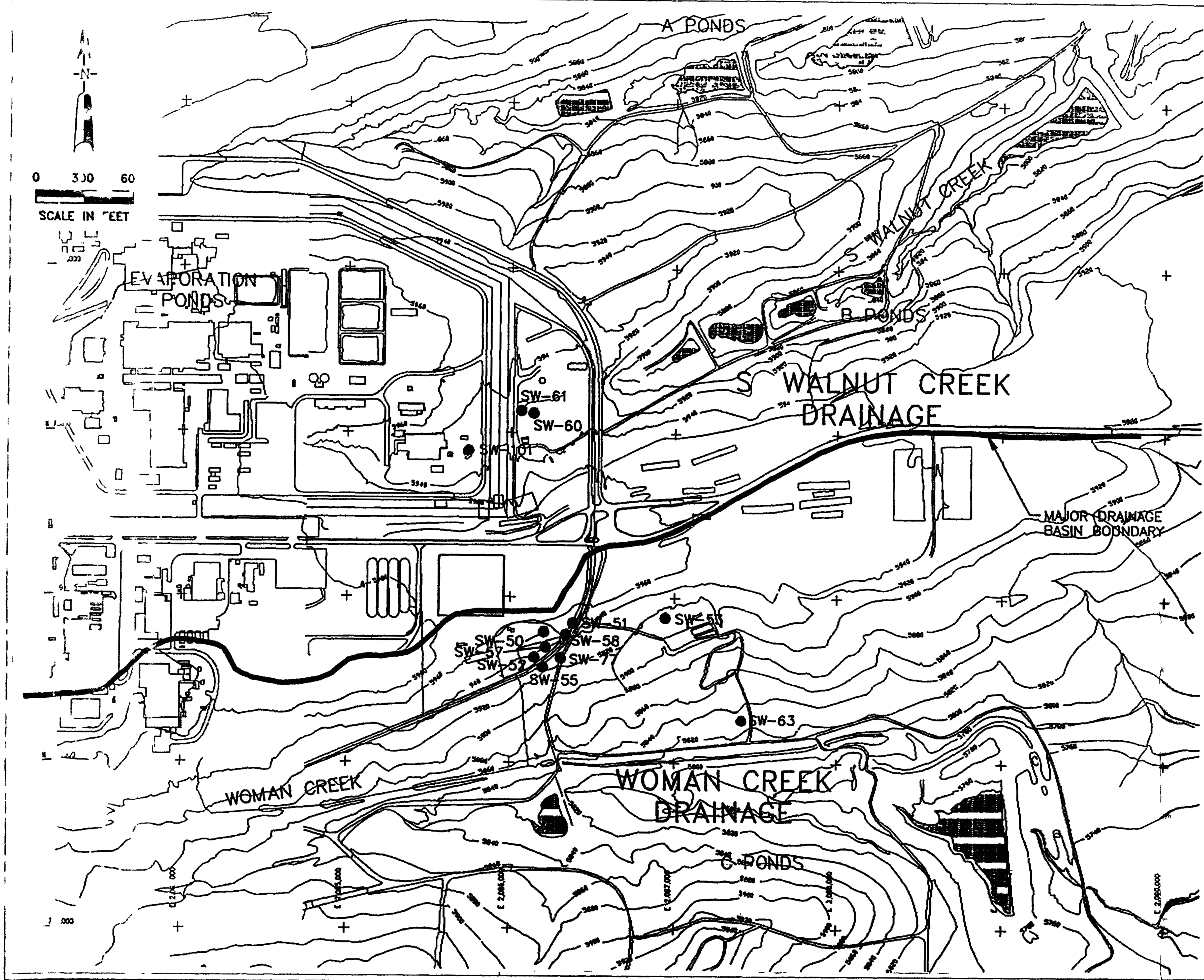
Figure A 17

Operable Unit No 2
Upland Habitats at the Rocky Flats Environmental Technology Site



EXPLANATION

● SW-60 SURFACE WATER SAMPLING LOCATION

SOURCE
ROCKY FLATS PLANT DRAINAGE AND FLOOD CONTROL MASTER PLAN DOE APRIL 1992

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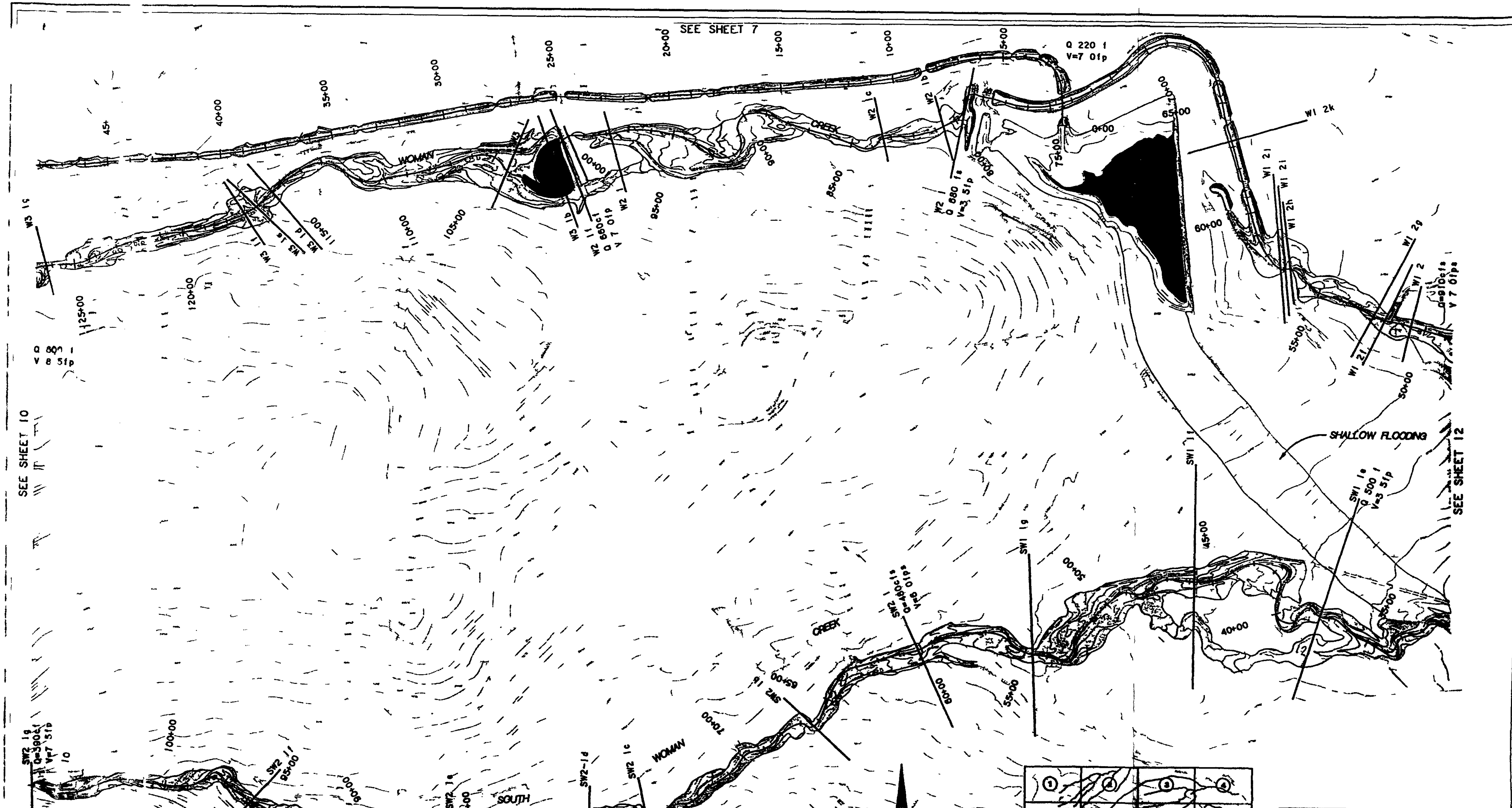
GOLDEN COLORADO

Figure A-7

**Operable Unit No 2
Ratine Surface Water Sampling Locations
in the Vicinnity of the 903 Pad**

PM4\EG&G\RF 1X17



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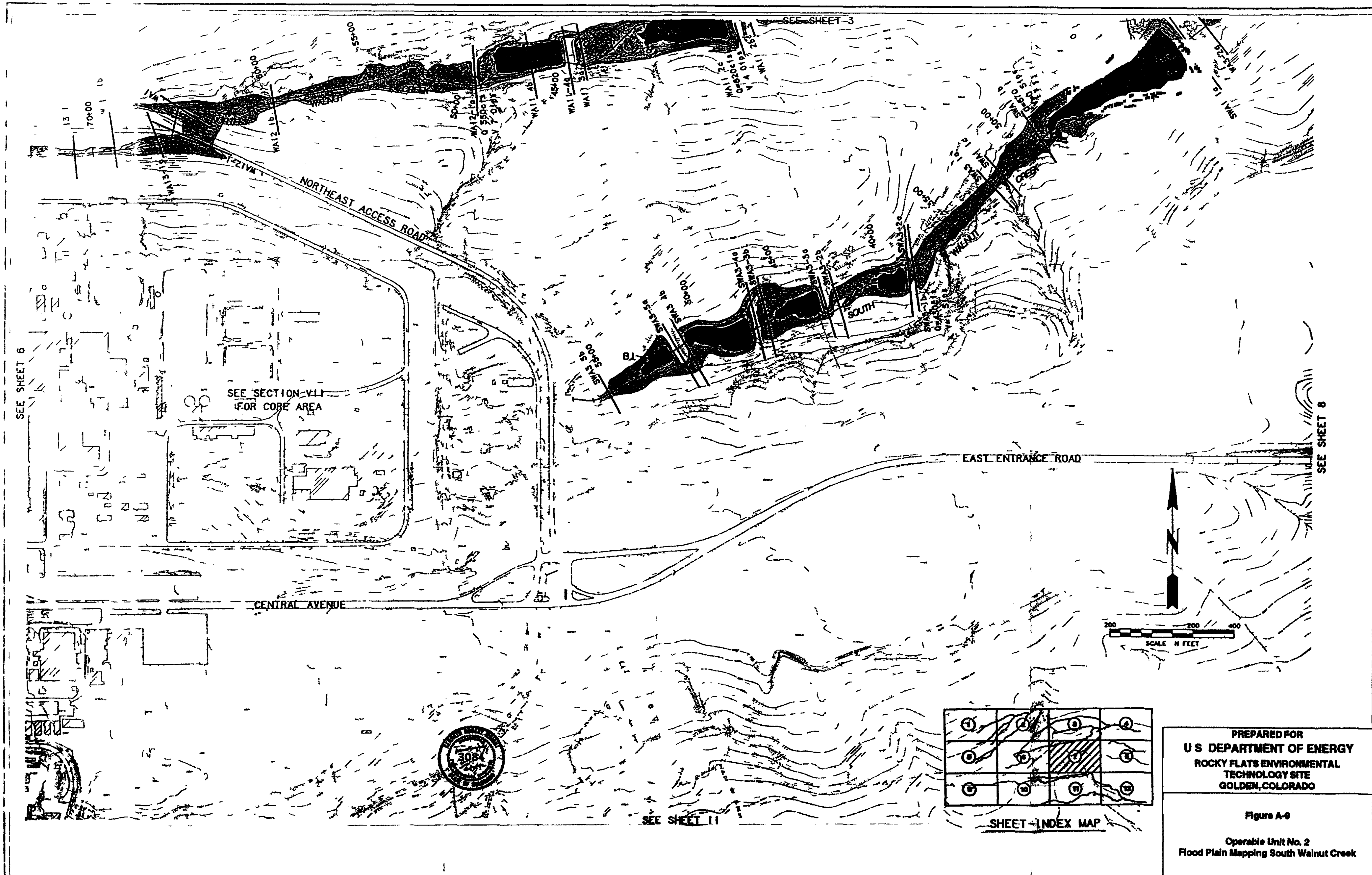
GOLDEN, COLORADO

Figure A-8

Operable Unit No. 2
Flood Plain Mapping South Woman Creek

G:\PM4\EG&G\R 11X17



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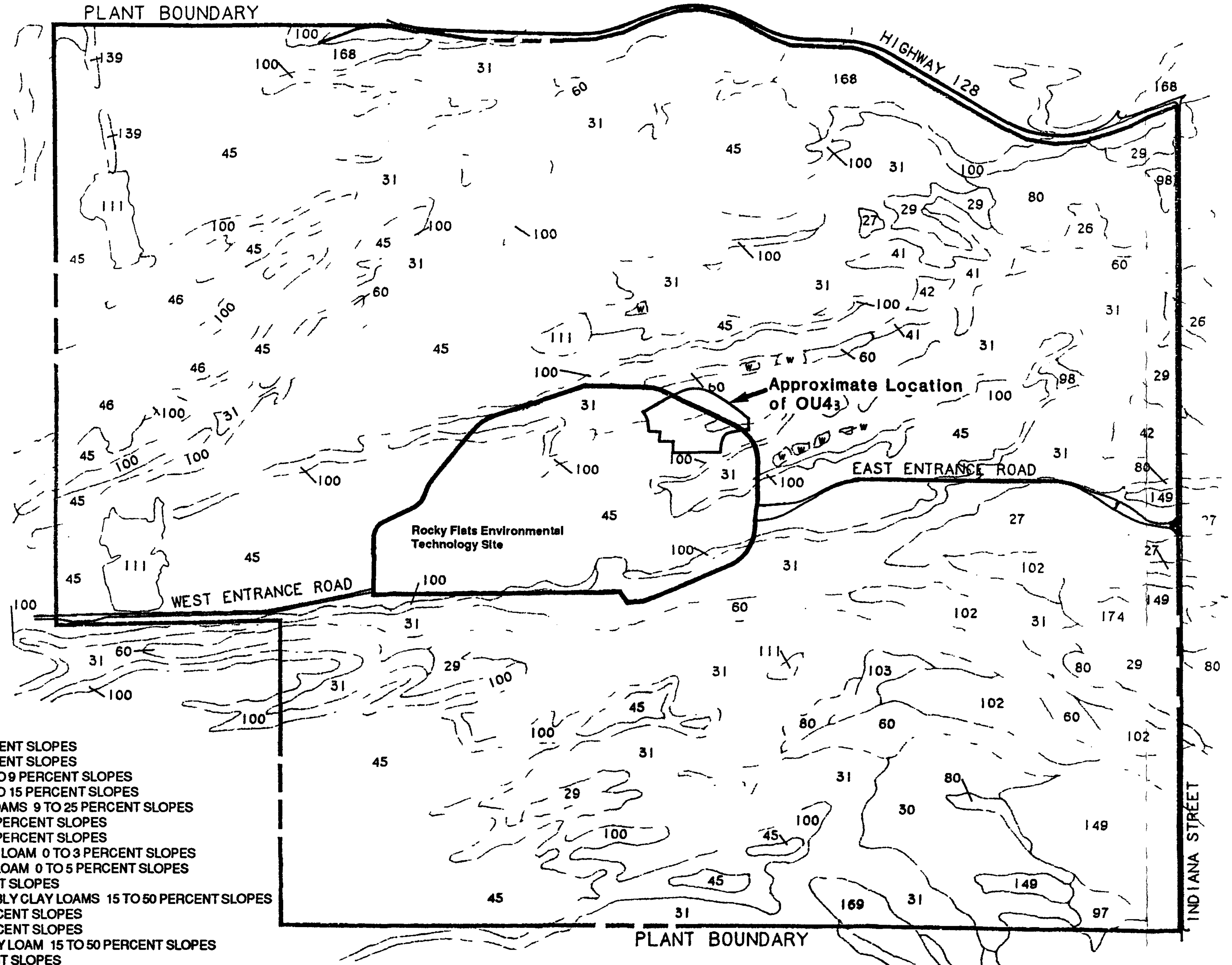
GOLDEN, COLORADO

Figure A-9

Operable Unit No. 2
Flood Plain Mapping South Walnut Creek

G:\PM4\EG&3\R 11X17



SOIL LEGEND

26 DENVER CLAY LOAM 2 TO 5 PERCENT SLOPES
27 DENVER CLAY LOAM 5 TO 9 PERCENT SLOPES
29 DENVER KUTCH CLAY LOAMS 5 TO 9 PERCENT SLOPES
30 DENVER KUTCH CLAY LOAMS 9 TO 15 PERCENT SLOPES
31 DENVER KUTCH MIDWAY CLAY LOAMS 9 TO 25 PERCENT SLOPES
41 ENGLEWOOD CLAY LOAM 0 TO 2 PERCENT SLOPES
42 ENGLEWOOD CLAY LOAM 2 TO 5 PERCENT SLOPES
45 FLATIRONS VERY COBBLY SANDY LOAM 0 TO 3 PERCENT SLOPES
46 FLATIRONS VERY STONY SANDY LOAM 0 TO 5 PERCENT SLOPES
60 HAVERSON LOAM 0 TO 3 PERCENT SLOPES
80 LEYDEN PRIMEN-STANDLEY COBBLY CLAY LOAMS 15 TO 50 PERCENT SLOPES
97 McCLAVE CLAY LOAM 0 TO 3 PERCENT SLOPES
98 MIDWAY CLAY LOAM 9 TO 30 PERCENT SLOPES
100 NEDERLAND VERY COBBLY SANDY LOAM 15 TO 50 PERCENT SLOPES
102 NUNN CLAY LOAM, 2 TO 5 PERCENT SLOPES
103 NUNN CLAY LOAM 2 TO 5 PERCENT SLOPES
111 PITS GRAVEL
139 ROCK OUTCROP SEDIMENTARY
149 STANDLEY NUNN GRAVELLY CLAY LOAMS 0 TO 5 PERCENT SLOPES
168 VALMONT CLAY LOAM 0 TO 3 PERCENT SLOPES
169 VELDKAMP NEDERLAND VERY COBBLY SANDY LOAMS 0 TO 3 PERCENT SLOPES
174 WILLOMANN LEYDEN COBBLY-LOAMS 9 TO 30 PERCENT SLOPES
w SURFACE WATER CONTROL STRUCTURES (RETENTION BASINS)

Source ASI 1991 "The SEPs ITS Ground Water Management Study

f11x17

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O e ble Unit N 2
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Rocky Flats